Public Works
Public Works - Engineering Division

Joel Pfundt, Director

Post Point Sludge Tank Replacement Project

Project No. EU194

Bid No. 3B-2026

For more information contact the purchasing office by telephone at (360) 778-7750 or by email at bids@cob.org.

CERTIFICATE PAGE

POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194

CITY OF BELLINGHAM

The engineering material and data contained in these Contract Documents were prepared under the supervision and direction of the undersigned, whose seal as a registered professional engineer is affixed below.

	Special Provisions Division 1 Stephen Day, P.E., S.E. City of Bellingham
Project Special Provisions: See Engineer Certification Pages within.	

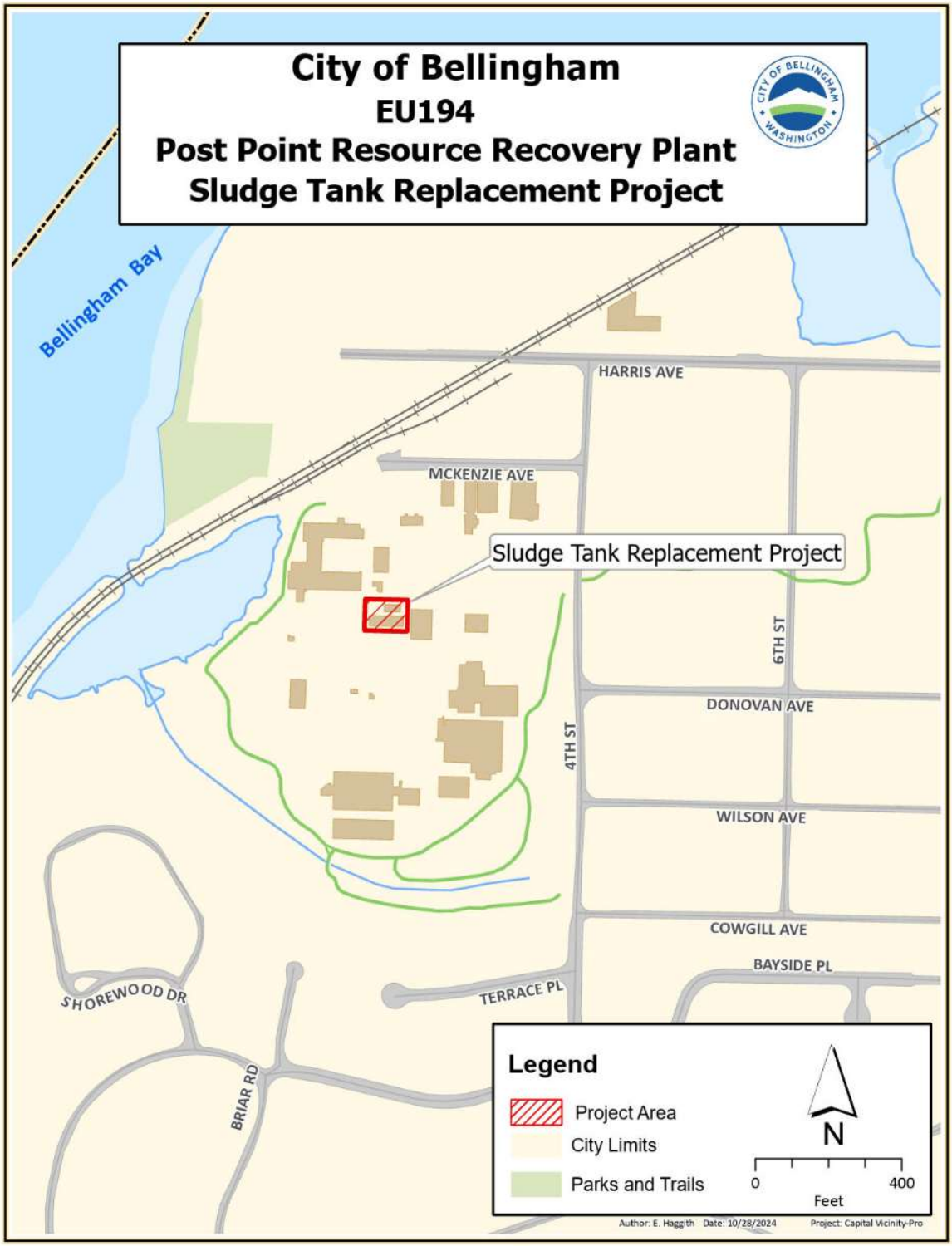

City of Bellingham
EU194
Post Point Resource Recovery Plant
Sludge Tank Replacement Project
Bellingham Bay
HARRIS AVE
MCKENZIE AVE
Sludge Tank Replacement Project
6TH ST
DONOVAN AVE
4TH ST
WILSON AVE
COWGILL AVE
BAYSIDE PL
TERRACE PL
SHOREWOOD DR
BRIAR RD
Legend
Project Area
City Limits
Parks and Trails
N
0
400
Feet
Author: E. Haggith Date: 10/28/2024
Project: Capital Vicinity-Pro

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INFORMATION FOR BIDDERS

POST POINT SLUDGE TANK REPLACEMENT PROJECT

EU194

CITY OF BELLINGHAM
NOTICE TO BIDDERS

BID NO. 3B-2026

Sealed proposals for the construction of the **POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194** project, will be received by the City of Bellingham, 210 Lottie Street, Bellingham, Washington, 98225 at the Purchasing Office until **October 14, 2026**, at 11:00 a.m., and thereafter will be publicly opened and read.

The improvement consists of:
Construction of Area 440 Sludge Storage Tanks and Odor Control System, and installation of new sludge pumps and sump pumps and associated equipment, instruments and piping in the existing Area 420 and 530. Structural modifications to existing building in Area 420 for new room separation and entrances. Demolition of existing Chlorine Building, demolition of portions of the structure, equipment and piping in Areas 420 and 530 to accommodate new equipment and structural features. Excavation, shoring, dewatering, and pile installation required for new construction in Area 440. Demolition and replacement of RAS pump discharge and header piping and two pumps, demolition and replacement of WAS pumps, installation of secondary clarifier dewatering pump and discharge piping, and temporary piping to accommodate the RAS work in Area 340. Work includes associated electrical equipment installation, heating, ventilation and air conditioning improvements, repair and reconstruction of existing structures affected by the Work, and incidentals for complete and usable facility, including commissioning of all installed work.

Price Range: $14,100,000 to $17,000,000

Plans, specifications, special provisions, basis to be used in comparing bids, proposal and contract can be viewed at the City of Bellingham website (https://cob.procureware.com/) or seen at the Purchasing Office, 210 Lottie Street, Bellingham, Washington, 98225, phone (360) 778-7750.

All proposals must be on the Bid Proposal form provided by the City of Bellingham and must be accompanied by a certified check, cashier's check, cash, money order or bid bond payable to the Finance Director in an amount equal to or exceeding five percent (5%) of the total bid. No other form of bid security is acceptable.

The right is reserved to postpone making the award for a reasonable length of time, to reject any and all bids, or to waive irregularities not affecting substantial rights.

Published: **September 4, 2026**

BID PROCEDURES AND CONDITIONS

This bid is subject to the bid procedures and conditions contained in Division 1 of the *Standard Specifications for Road, Bridge and Municipal Construction*, most recent Edition, issued by the Washington State Department of Transportation ("Standard Specifications"), incorporated herein by this reference. The bid procedures and conditions contained in the Standard Specifications are modified or supplemented as follows:

1. **Definitions**. Capitalized terms not specifically defined herein shall have the meaning ascribed to them in the Standard Specifications.

    a) The City of Bellingham may be referred to hereinafter as the "City".
    b) Where the terms "Washington State Transportation Commission", "State Department of Transportation", or variations of same are used in the Standard Specifications, they shall be construed to mean "City" or "Owner".
    c) Where the term "State Treasurer" is used in the Standard Specifications, the term shall be construed to mean the City's "Finance Director".
    d) Where the term "Secretary of Transportation" or "District Administrator" are used in the Standard Specifications, the terms shall be construed to mean the duly authorized representative of the City.

2. **Bid Bond-Hard Copy.** Standard Specification § 1-02.7, "Bid Deposit", is modified as follows: Bid Bond must be submitted in hard copy with the bid submittal. Electronic submittals will not be accepted.

3. **Delivery of Proposal-Hard Copy**. Standard Specification § 1-02.9, "Delivery of Proposal", is modified as follows: Bids must be submitted in hard copy in a sealed envelope. Electronic submittals will not be accepted. It is the bidder's responsibility to deliver its bid proposal and supporting documents to the proper address by the assigned time. The City accepts no responsibility for misdirected or lost bids or supporting documents prior to the City actually receiving them.

4. **Bid Documents**. Bid Documents include all documents and materials published for this project at https://cob.procureware.com/, including all documents and materials referenced therein.

5. **Addenda**. Addendum (Addenda) are written or graphic instructions issued by the City's Purchasing Office prior to the receipt of bids in accordance with these Bid Procedures and Conditions, which interpret, clarify, correct, modify, add, or delete portions of the Bid Documents. Addenda will become part of the Contract when the Public Works Agreement is executed.

6. **Plan Holder's List**. The plan holder's list is the way in which the City will notify bidders of changes in the Bid Documents. All changes to Bid Documents will be issued by the Purchasing Office. The City will notify holders by email. The City will make a reasonable effort to notify bidders of changes; however the sole responsibility lies upon the bidder to inquire if a change has been issued prior to the bid opening time and date. Please visit the web site at https://cob.procureware.com/ or call the Purchasing Office as 360-778-7750 to verify Addenda prior to submitting a bid.

7. **Questions/Objections**. Bidders are requested to review the Bid Documents carefully, without delay, for defects and questionable or objectionable matter. Questions, objections or comments regarding the Bid Documents or bid process should be made in writing and received by the issuing office no later than five (5) business days' prior to bid opening so that any necessary addenda may be published and distributed to bidders prior to the bid submission deadline; provided that the City may in its sole discretion respond to questions submitted after that deadline. All communications should be in writing and addressed to the following: City of Bellingham, Purchasing Office, 210 Lottie Street, Bellingham, Washington 98225.

8. **Bid Protest**. In accordance with RCW 39.04.105, if the City receives a written protest from a bidder, the City will not execute a contract for the project with anyone other than the protesting bidder without first providing at least two (2) full business days' written notice of the City's intent to execute a contract for the project; provided that the protesting bidder submits notice in writing of its protest no later than two (2) full business days' following bid opening. Any protest must be made in writing, signed by the protesting bidder or its authorized agent, and filed with the City's Purchasing Manager, 210 Lottie Street, Bellingham, WA 98225, with a copy to the City Attorney, 210 Lottie Street, Bellingham, WA 98225. The protest shall contain all of the following information:

   a) The protestor's name, address, and phone/facsimile number;
   b) The bid number and bid project name;
   c) A detailed description of the specific factual and legal ground(s) for the protest, including all exhibits referenced by the protestor; and
   d) The specific ruling and relief requested.

   The City reserves the right to reject all bids as a remedy to a protest or independently of protests. Failure to comply with these procedures shall render a protest untimely or inadequate and, consequently, may result in the City rejecting the protest solely on this basis. Any decision made by the City regarding the bid award, contract execution or bid rejection shall be final, subject to such judicial review as permitted under Washington

law upon timely filing in the Superior Court of Whatcom County, Washington. This venue clause shall modify any other provision in these Bid Documents to the extent there is an inconsistency.

9. **Substitutions**. Each bidder represents that its bid is based on the material and equipment described in the Bid Documents. During the bidding period, no substitutions will be considered unless written request has been submitted to the City for approval at least five (5) working days' prior to the date for receipt of bids. Each such request shall include a complete description of the proposed substitute; the name of the material or equipment for which it is to be substituted; drawings, cuts, performance and test data; and any other data or information necessary for complete evaluation. Request for substitutions shall be sent to the Purchasing Manager. If the City approves any proposed substitution, such approval will be set forth in an addendum.

10. **Payment & Performance Contract Bond**. Prior to contract execution, the successful bidder shall submit a Payment and Performance Contract Bond in the form included in this bid packet. On contracts of one hundred fifty thousand dollars ($150,000) or less, at the Contractor's option, the City will, in lieu of a Payment and Performance Contract Bond, withhold retainage of ten percent (10%) of the contract amount until releasable under RCW 39.08.010.

11. **Bid Rejection.** The City reserves the right to reject any and all Bid Proposals, to waive minor deviations from the Bid Procedures and Conditions, or to waive any informality or minor irregularity in Bid Proposals received, whenever such rejection or waiver is in the best interest of the City. Among other things, a Bid Proposal may be rejected when: (1) the bidder is in arrears on taxes or other claims due the City; (2) the bidder is not in a position to perform the Contract; (3) the Bid Proposal is not signed; (4) the bidder fails to furnish bid bonds or surety deposits, plans, specifications, samples, etc., when such were specifically called for in the Bid Documents; (5) the bidder has failed to use the Bid Proposal form attached; (6) the bidder makes a material change in the Bid Documents; (7) the Bid Proposal contains a material alteration or erasure which is not initialed by the signer of the solicitation; (8) the bidder has been debarred from public bidding by either the State of Washington or the United States Federal Government; (9) any other reason determined to be in the best interest of the City.

12. **Pre-Award Information**. Standard Specification § 1-02.15, "Pre-Award Information", is modified to add the following items to the list of items that the City may require the bidder to provide following bid opening and prior to bid award:

a) A satisfactory statement of costs for each major item of work included in the Bid Proposal which will be used as the basis for payment applications.
b) A designation of the amount and type of work to be performed by the Contractor's own forces.
c) A list of names of the subcontractors or other persons or organizations proposed for such portions of the work and an estimated employment profile of such subcontractor's forces. Subcontractors, employees, and other persons and organizations proposed by the Contractor and accepted by the City must be used on the work for which they were proposed and accepted and shall not be changed without the City's written approval.

13. **City Business Registration**. Bidders are required to possess a City of Bellingham Business Registration Certificate prior to bid award and will be required to pay business and occupation taxes. For additional information, check with the City's Finance Department, (360) 778-8000.

14. **Bid Preparation Costs**. The City shall not be liable for any costs incurred by the bidder in bid preparation.

15. **Prevailing Wage.** This project is a public work subject to State of Washington prevailing wage law, Chapter 39.12 RCW. Prevailing wage rates applicable to this project, which is located in Whatcom County, Washington, are available on the Washington State Department of Labor & Industries' website at: https://secure.Lni.wa.gov/wagelookup. The applicable effective date for prevailing wages is the bid submittal deadline. A hard copy of applicable prevailing wage rates is available for viewing at the City's Purchasing Office and will be mailed upon request.

16. **Agreement Form.** The City's Public Works Agreement form is attached. The successful bidder will be required to enter into such an agreement with the City.

17. **Parking Meter Hoods**. The successful bidder is responsible for all costs to secure parking meter hoods and parking space. Contact City Parking Services at (360) 778-7780 for additional information.

18. **Insurance Requirements**. The insurance requirements for this project are contained in Section 1-07.18 of the Standard Specifications.

19. **Evidence of Insurance**. The successful bidder shall provide the following evidence of insurance to the City prior to the City's execution of the Public Works Agreement:

a) **Certificate of Insurance** listing all required insurance policies. The Certificate of Insurance shall be an ACORD form or a form determined by the City to be equivalent.

b) **Additional Insured Endorsement** naming the City as an additional insured on the successful bidder's commercial general liability ("CGL") policy. The endorsement shall reference the CGL policy number. Contractor may submit a copy of a blanket additional insured clause from its CGL policy in lieu of a separate endorsement. A statement of additional insured status on an ACORD Certificate of Insurance will not satisfy this requirement. Per Standard Specification 1-07.18, additional insured coverage must include products/completed operations coverage.

20. **Reciprocal Preference for Resident Contractor**. In accordance with RCW 39.04.380, the City of Bellingham is enforcing a Reciprocal Preference for Resident Contractors. Any public works bid received from a nonresident contractor from a state that provides an in-state percentage bidding preference, a comparable percentage disadvantage must be applied to the bid of that nonresident contractor. A nonresident contractor from a state that provides a percentage bid preference means a contractor that:

a) is from a state that provides a percentage bid preference to its resident contractors bidding on public works contracts; and
b) at the time of bidding on a public works project, does not have a physical office located in Washington.

The state of residence for a nonresident contractor is the state in which the contractor was incorporated or, if not a corporation, the state where the contractor's business entity was formed. All nonresident contractors will be evaluated for out of state bidder preference. If the state of the nonresident contractor provides an in-state contractor preference, a comparable percentage disadvantage will be applied to their bid prior to contract award. This section does not apply to public works procured pursuant to RCW 39.04.155, 39.01.280, or any other procurement exempt from competitive bidding.

PRE-BID MEETING AT PROJECT SITE

The Post Point Resource Recovery Plant is a secured facility, and is only open for tours to the public by appointment. Two (2) voluntary, optional events will be held for interested bidders to tour the project site on the following dates: **September 17, 2026 at 10:00am and on Monday September 28, 2026 at 10:00am**. Contractors who would like to attend either of these optional events must RSVP to request and confirm attendance. RSVP for this event shall be made online via the City's Bid Portal (https://cob.procureware.com/) under the Bid Events section of this bid.

The Pre-Bid Meeting will be held at the Post Point Resource Recovery Plant, 200 McKenzie Avenue, Bellingham, WA 98225. Personal Protective Equipment is required at this facility. Due to space constraints, each prospective bidder is limited to three attendees.

Sign-in sheets and any questions/answers discussed at the Pre-Bid Meeting will be distributed as Addenda to the Bid.

BIDDERS CHECKLIST

THIS BIDDERS CHECKLIST has been prepared and furnished to aid bidders in including all necessary forms and information with their bid. However, it is not guaranteed to be complete, and the responsibility for compliance with all bidding requirements remains with the bidder.

ALL BIDDERS must properly complete, execute and submit the following forms with their bids ***prior*** to the bid submission deadline:

- ☐ Bid Proposal
- ☐ Bid Bond (or Bid Deposit)
- ☐ Mandatory Bidder Responsibility Checklist
- ☐ Subcontractor Listing Form
- ☐ Any other forms included in the Bid Documents that are designated as being due at the time of bid submission

Note: Bidder must write or print the Bid No. for this project on the face of the sealed envelope containing its bid.

The **APPARENT LOW BIDDER** shall properly complete, execute and submit the following form ***after*** bid opening within two (2) business days of being notified by the City that it is the apparent low bidder:

- ☐ Supplemental Bidder Responsibility Criteria Form

The **SUCCESSFUL BIDDER** shall properly complete, execute and submit the following forms ***after*** receiving notice that it has been awarded the contract:

- ☐ Public Works Agreement
- ☐ Payment and Performance Contract Bond
- ☐ Retainage Investment Option (and Escrow or Savings Account Agreement, if any)
- ☐ Certificate of Insurance and Additional Insured Endorsement
- ☐ Any other documents required by the City

BIDDER RESPONSIBILITY CRITERIA
POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194

MANDATORY BIDDER RESPONSIBILITY CRITERIA

1. **Requirement**. Before award of a public works contract for this Project, the bidder must meet the mandatory bidder responsibility criteria contained in RCW 39.04.350(1), as reiterated below.

2. **Criteria**. The bidder must:

a. Have a current certificate of registration as a contractor in compliance with Chapter 18.27 RCW, which must have been in effect at the time of bid submittal;

b. Have a current Washington Unified Business Identifier (UBI) number;

c. If applicable, show proof of: (a) Industrial Insurance (workers' compensation) coverage for the bidder's employees working in Washington, as required in Title 51 RCW; (b) a Washington Employment Security Department number, as required in Title 50 RCW; and, (c) a Washington Department of Revenue state excise tax registration number, as required in Title 82 RCW;

d. Not be disqualified from bidding on any public works contract under RCW 39.06.010 or 39.12.065(3); and

e. For public works projects subject to the apprenticeship utilization requirements of RCW 39.04.320, not have been found out of compliance by the Washington state apprenticeship and training council for working apprentices out of ratio, without appropriate supervision, or outside their approved work processes as outlined in their standards of apprenticeship under chapter 49.04 RCW for the one-year period immediately preceding the first date of advertising for the project.

f. Have received training on the requirements related to public works and prevailing wage under this chapter and chapter 39.12 RCW. The bidder must designate a person or persons to be trained on these requirements. The training must be provided by the department of labor and industries or by a training provider whose curriculum is approved by the department. Bidders that have completed three or more public works projects and have had a valid business license in Washington for three or more years are exempt from this subsection.

g. Within the three-year period immediately preceding the date of the bid solicitation, not have been determined by a final and binding citation and notice of assessment issued by the Washington State Department of Labor and Industries or through a civil judgment entered by a court of limited or general jurisdiction to have willfully violated, as defined in RCW 49.48.082, any provision of chapter 49.46, 49.48, or 49.52 RCW

3. **Documentation**. Bidder shall complete and sign the Mandatory Bidder Responsibility Checklist provided below and submit it to the City with its bid.

4. **Verification of Subcontractor Responsibility Criteria.** In accordance with RCW 39.06.020, the successful bidder must verify responsibility criteria for each first tier subcontractor, and a subcontractor of any tier that hires other subcontractors must verify responsibility criteria for each of its subcontractors. Verification shall include that each subcontractor, at the time of subcontract execution, meets the responsibility criteria listed in RCW 39.04.350(1) and possesses an electrical contractor license, if required by Chapter 19.28 RCW, or an elevator contractor license, if required by Chapter 70.87 RCW. This verification requirement, as well as the responsibility criteria, must be included in every public works contract and subcontract of every tier.

MANDATORY BIDDER RESPONSIBILITY CHECKLIST

Bid Number:	Bid Submittal Deadline:
Project Name:	Project Number:
Bidder's Business Name:	City Business Registration Number: Active? Yes ☐ No ☐
CONTRACTOR REGISTRATION https://secure.lni.wa.gov/verify/	
License Number:	License Active? Yes ☐ No ☐
Effective Date:	Expiration Date:
UBI/TAX REGISTRATION NUMBER https://secure.dor.wa.gov/gteunauth/ (go to Business Lookup)	
UBI/TAX Registration Number:	Account: Open ☐ Closed ☐
INDUSTRIAL INSURANCE COVERAGE https://fortress.wa.gov/lni/crpsi/MainMenu.aspx	
Account Number:	Account Current? Yes ☐ No ☐
EMPLOYMENT SECURITY DEPARTMENT	
Employment Security Department Number:	
Has Bidder provided account number on the Bid Form?	Yes ☐ No ☐
NOT DISQUALIFIED FROM BIDDING	
https://secure.lni.wa.gov/debarandstrike/ContractorDebarList.aspx	
Is the Bidder listed on the "Debarred Contractors List" list of the Washington State Department of Labor and Industries Website?	Yes ☐ No ☐
https://www.SAM.gov/ (go to Search Records)	
Is the bidder listed on the current debarred or suspended bidder list available on the U.S. General Services Administration's System for Award Management ("SAM") website?	Yes ☐ No ☐

BIDDER CERTIFICATIONS

1. The bidder hereby certifies under penalty of perjury under the laws of the State of Washington that, within the 3-year period immediately preceding the bid solicitation date, the bidder is not a "willful" violator, as defined in RCW 49.48.082, of any provision of RCW 49.46, 49.48, or 49.52, as determined by a final and binding citation and notice of assessment issued by the Department of Labor and Industries or through a civil judgment entered by a court of limited or general jurisdiction.
2. The undersigned further certifies that bidder (check one):
   - ☐ Has received training on the requirements related to public works and prevailing wage as mandated in RCW 39.04.350(1)(f) or
   - ☐ Is exempt from such training because it has completed three or more public works projects and has had a valid business license in Washington for three or more years.
3. The undersigned further certifies that all other information provided by or on behalf of bidder on this form is true and correct.

Signature of Authorized Official	Date
Print Name & Title	Place of Execution (City & State)

CITY VERIFICATION

City Purchasing Manager or Designee	Date
Has bidder satisfied applicable supplemental responsibility criteria?	Yes ☐ No ☐ *Documentation on file*

SUBCONTRACTOR RESPONSIBILITY CHECKLIST

The following checklist is given to Contractors and Subcontractors for documenting that a subcontractor of any tier meets the subcontractor responsibility criteria. It is suggested that Contractors and Subcontractors print a copy of documentation from the appropriate website to include with this checklist in their contract file.

GENERAL INFORMATION	
Project Name:	Project Number:
Subcontractor's Business Name:	City Business Registration Number: Active? Yes ☐ No ☐
SUBCONTRACTOR REGISTRATION https://secure.lni.wa.gov/verify/	
License Number:	License Active? Yes ☐ No ☐
Effective Date:	Expiration Date:
UBI/TAX REGISTRATION NUMBER https://secure.dor.wa.gov/gteunauth/ (go to Business Lookup)	
UBI/Tax Registration Number:	Account: Open ☐ Closed ☐
INDUSTRIAL INSURANCE COVERAGE https://fortress.wa.gov/lni/crpsi/MainMenu.aspx	
Account Number:	Current: Yes ☐ No ☐
EMPLOYMENT SECURITY DEPARTMENT	
Employment Security Department Number:	
NOT DISQUALIFIED FROM BIDDING	
https://secure.lni.wa.gov/debarandstrike/ContractorDebarList.aspx	
Is the Subcontractor listed on the "Debarred Contractors List" on the Washington State Department of Labor and Industries website?	Yes ☐ No ☐
https://www.SAM.gov/ (go to Search Records)	
Is the Subcontractor listed on the current debarred or suspended bidder list available on the U.S. General Services Administration's System for Award Management ("SAM") website?	Yes ☐ No ☐
SPECIALITY CONTRACTOR LICENSES https://fortress.wa.gov/lni/bbip/	
Electrical: If required by Chapter 19.28 RCW, does the Subcontractor have an Electrical Contractor's License?	Yes ☐ No ☐ N/A ☐
Elevator: If required by Chapter 70.87 RCW, does the Subcontractor have an Elevator Contractor's License?	Yes ☐ No ☐ N/A ☐

SUBCONTRACTOR CERTIFICATIONS

1. The bidder hereby certifies under penalty of perjury under the laws of the State of Washington that, within the 3-year period immediately preceding the bid solicitation date, the bidder is not a "willful" violator, as defined in RCW 49.48.082, of any provision of RCW 49.46, 49.48, or 49.52, as determined by a final and binding citation and notice of assessment issued by the Department of Labor and Industries or through a civil judgment entered by a court of limited or general jurisdiction.
2. The undersigned further certifies that bidder (check one):
   - ☐ Has received training on the requirements related to public works and prevailing wage as mandated in RCW 39.04.350(1)(f) or
   - ☐ Is exempt from such training because it has completed three or more public works projects and has had a valid business license in Washington for three or more years.
3. The undersigned further certifies that all other information provided by or on behalf of bidder on this form is true and correct.

Signature of Authorized Official	Date
Print Name & Title	Place of Execution (City & State)

PRIME CONTRACTOR VERIFICATION	
Sign	Date
Print Name & Title	

SUPPLEMENTAL BIDDER RESPONSIBILITY CRITERIA

1. **Requirement.** Before award of a public works contract for this Project, the bidder must meet the supplemental bidder responsibility criteria established by the City pursuant to RCW 39.04.350(2), as set forth in this Supplemental Bidder Responsibility Form ("Form").

2. **Instruction to Bidders.** This Form, and all documentation required herein, shall be completed in its entirety and submitted to the City by the apparent low bidder within two (2) business days of being notified by the City that it is the apparent low bidder; provided that any requested modifications to these supplemental criteria are due five (5) days prior to the bid submission deadline pursuant to Section 5 below. Failure to meet this requirement may render the bid nonresponsive and/or the bidder not responsible.

3. **Certification.** The undersigned certifies that he/she is authorized to submit this Form on behalf of the bidder and that all bidder information supplied pursuant hereto is accurate.

Name of Bidder: _____

Address: _____

Phone: _____

Name of Person Completing this Form (Print): _____

Title: _____

Signature: _____

Date: _____

4. **Criteria & Required Documentation.**

a. DELINQUENT STATE AND/OR CITY OF BELLINGHAM TAXES

i. **Criterion**: The bidder shall not owe delinquent taxes to either the Washington State Department of Revenue or the City of Bellingham without a payment plan approved by the Department of Revenue and/or City of Bellingham before the date of award.

ii. **Check applicable box:**

☐ The bidder <u>does not</u> owe delinquent taxes to either the Washington State Department of Revenue or the City of Bellingham without a payment plan approved by the Department of Revenue and/or City of Bellingham before the date of award.

☐ Alternatively, the bidder does owe delinquent taxes to either the Washington State Department of Revenue or the City of Bellingham without a payment plan approved by the Department.

b. PREVAILING WAGES COMPLAINTS

i. **Criterion**: The bidder shall not have a record of prevailing wage complaints against it within five (5) years of the bid submittal date that demonstrates a pattern of failing to pay workers prevailing wages, unless there are extenuating circumstances acceptable to the City in its sole discretion.

ii. **Check applicable box**:

☐ The bidder has not had any prevailing wage complaints filed against it within five (5) years prior to the bid submittal date.

☐ Alternatively, the bidder has had prevailing wage complaints filed against it within five (5) years of the bid submittal date.

iii. **Documentation**: If the Bidder has had prevailing wage complaints filed against it within five years of the bid submittal date, then bidder shall submit a list of complaints filed against the Bidder and include for each complaint the name of Project, Owner and contact information for Owner, and a written explanation of the circumstances surrounding each complaint and how it was resolved. The City shall evaluate these explanations and the resolution of each complaint to determine whether the complaints demonstrate a pattern of failing to pay its workers prevailing wages as required. The City reserves the right to conduct its own investigation into prevailing wage complaints and may also evaluate complaints filed within the time period specified that were not reported by the bidder.

c. CLAIMS AGAINST RETAINAGE AND PAYMENT AND PERFORMANCE BONDS

i. **Criterion**: The bidder shall not have a record of excessive claims filed against the retainage or payment and performance bonds for public works projects in the three (3) years prior to the bid submittal date that demonstrate a lack of effective management by the bidder of making timely and appropriate payments to its subcontractors, suppliers, and workers, unless there are extenuating circumstances acceptable to the City in its sole discretion.

ii. **Check applicable box**:

☐ The Bidder has not had claims against retainage or payment and performance bonds in the three (3) years prior to the bid submittal date.

☐ Alternatively, the Bidder has had claims against retainage or payment and performance bonds in the three (3) years prior to the bid submittal date.

iii. **Documentation**: If the Bidder has had claims against retainage or payment and performance bonds in the three (3) years prior to the submittal date, submit a list of public works projects completed during this period that have had claims against retainage or payment and performance bonds and include name of Project, Owner, and contact information for the Owner, a list of claims filed against retainage or payment and performance bond for any of the projects listed; and a written explanation of circumstances surrounding each claim and the ultimate resolution of the claim.

d. PUBLIC BIDDING CRIME

i. **Criterion**: The bidder and/or its owner(s) shall not have been convicted of a crime involving bidding on a public works contract within five (5) years from the bid submittal date.

ii. **Check applicable box**:

☐ The bidder and/or its owner(s) have not been convicted of a crime involving bidding on a public works contract in the five (5) years prior to the bid submittal date.

☐ Alternatively, the bidder and/or its owner(s) have been convicted of a crime involving bidding on a public works contract in the five (5) years prior to the bid submittal date.

e. TERMINATION FOR CAUSE

i. **Criterion**: The bidder shall not have had any public works contract terminated for cause by a government agency or municipality during the five (5) year period immediately preceding the bid submittal date, unless there are extenuating circumstances acceptable to the City in its sole discretion.

ii. **Check applicable box:**

☐ The bidder has not had any public works contracts terminated for cause by a government agency or municipality in the five (5) years prior to the bid submittal date.

☐ Alternatively, the bidder has had one or more public works contracts terminated for cause by a government agency or municipality in the five (5) years prior to the bid submittal date.

iii. **Documentation**: If the bidder has had one or more public works contracts terminated for cause by a government agency or municipality during the five (5) year period immediately preceding the bid submittal date, then the bidder shall provide the City with a list of each contract terminated, the name of the government agency or municipality who terminating the contract, and the circumstances involving the termination for cause. The City reserves the right to use independent sources of information that may be available to demonstrate whether the bidder complies with this criterion.

f. LAWSUITS

i. **Criterion**: The bidder shall not have any judgment(s) or award(s) entered against it in any lawsuits or arbitrations within five (5) years of the bid submittal date that demonstrate a pattern of failing to meet the terms of contracts, unless there are extenuating circumstances acceptable to the City in its sole discretion.

ii. **Check applicable box:**

☐ The bidder has not had any judgement(s) or award(s) entered against it in the five (5) years prior to the bid submittal date.

☐ Alternatively, the bidder has had judgment(s) or award(s) entered against it in the five (5) years prior to the bid submittal date that demonstrate a pattern of failing to meet the terms of contracts.

iii. **Documentation**: If the bidder has had any judgment(s) or award(s) entered against it in the five (5) years prior to the bid submittal date, then the bidder shall submit a list of lawsuits or arbitrations in which such judgement(s) or award(s) were entered along with a written explanation of the circumstances surrounding each. The City shall evaluate these explanations to determine whether the lawsuits and/or arbitrations demonstrate a pattern of failing to meet

terms of contracts. The City reserves the right to conduct its own independent investigation.

g. REFERENCES

The City reserves the right to check references, whether identified by the bidder or not, on all bidders, including using itself as a reference in applicable situations. In evaluating references, the City will check with other owners regarding, by way of example, such things as: quality control, safety record; timeliness of performance; use of skilled and trained personnel; management of subcontractors; availability of and use of appropriate equipment; compliance with contract documents; management of submittals process, change orders, force account, and close-out; and other applicable project information deemed appropriate by the City.

5. Modifications to Supplemental Bidder Responsibility Criteria

a. Potential bidders may request modifications to the City's supplemental bidder responsibility criteria as defined herein by submitting a written request ("Request") to the City's Purchasing Office no later than five (5) business days prior to the bid submission deadline designated for the project. Requests may be submitted via U.S. post mail, delivered personally, or sent by electronic mail or fax within this timeline to:
   - Mail/Delivery: Purchasing Office, City of Bellingham, 210 Lottie Street, Bellingham, WA, 98225
   - Fax: 360-778-8001 (Attn: Purchasing/Criteria Modification Request)
   - Email: bids@cob.org

b. Requests either not addressed to the Purchasing Office as indicated above or Requests received after this date and time will not be considered.

c. The Request must include the bidder's name and address, the applicable criteria the bidder is seeking to modify, the justification for why the identified criteria should be modified, and how the requestor would like the criteria modified. Please include the Specification Number and Project Title when submitting all such Requests. Requests either not addressed to the Purchasing Office or Requests not received no later than five (5) business days prior to the bid opening date will not be considered.

d. Any changes to the supplemental criteria, as determined by the City in its sole discretion, will be issued by addenda to the solicitation documents and posted to the City's website for the attention of all prospective bidders.

6. Supplemental Bidder Responsibility Determination and Appeal Process

a. If the City determines the bidder does not meet the supplemental bidder criteria as outlined above and is therefore not a responsible bidder, the City shall notify the bidder in writing with the reasons for its initial determination.
b. If the bidder disagrees with the City's initial determination, the bidder will have one (1) business day from receiving the initial determination to appeal it by submitting additional written information to the City.
c. The City will consider any such timely submitted additional information received from bidder before issuing its final determination.
d. If the final determination affirms that the bidder is not responsible, the City will not execute a contract with any other bidder until two (2) business days after the bidder determined to be not responsible has received the final determination.

FINAL DETERMINATION OF BIDDER RESPONSIBILITY

Reserved for City Use Only

I, the undersigned, have reviewed the following: (1) the foregoing supplemental bidder responsibility criteria form submitted by the presumptive low bidder; (2) additional information submitted by the presumptive low bidder in accordance with Section 6 above, if any; and (3) additional information obtained during my evaluation of bidder's submission, if any. Based on my review, I have determined on behalf of the City of Bellingham that bidder (is ___) (is not ___) responsible. This final determination was made in accordance with the procedures set forth in Section 6 above.

_____ _____

City Purchasing Manager or Designee Date

-- End of Supplemental Bidder Responsibility Form --

BID SUBMITTALS

POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194

EXHIBIT A
TO PUBLIC WORKS AGREEMENT

BID PROPOSAL

To the City of Bellingham:

The undersigned bidder declares that he/she has carefully examined the Bid Documents, including the Contract Plans, Provisions, and Specifications for the construction of the POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194, project, has made an examination of the site of the proposed work, has made such investigations as are necessary to determine the conditions to be encountered, and that if this Bid Proposal is accepted, he/she will contract with the City of Bellingham, Washington (the "City"), in the form of contract hereto annexed, and will to the extent of his bid provide the necessary machinery, tools, apparatus and other means of construction, and will furnish all materials and labor as specified in the manner herein specified and according to the requirements of the Engineer.

The bidder agrees that they will complete all work as required within **450 working days**. The bidder further agrees that they will pay liquidated damages for delay in completion as specified in Standard Specification 1-08.9.

No Washington State Sales Tax will be paid by the City on labor or services on street related items of work. For street related items of work, the bidder shall include within its Base Bid any contractor-paid Washington State Retail Sales Tax on materials, equipment, or supplies used or consumed in doing the work. For non-street related items of work, including water and sewer, Washington State Retail Sales Tax will be paid by the City and the amount of such tax shall be separately stated by the bidder in the space provided on this Bid Proposal form.

Bid Item	**Description**	**Unit**	**Price in Figures ($)**
1	Mobilization and Demobilization	LS	
2	Chlorine Building Demolition Work	LS	
3	Auger Cast Piles	LS	
4	Temporary Excavation Support	LS	
5	Dewatering	LS	
6	Site Civil Work	LS	
7	Area 050 Work	LS	
8	Area 340 Work	LS	
9	Area 420 Work	LS	
10	Area 440 Work	LS	
11	Area 510 Work	LS	
12	Area 530 Work	LS	
13	Electrical, Instrumentation, and Controls	LS	
14	Record Documents (Minimum Bid $25,000)	LS	
Bid Item Subtotal			
Sales Tax (9.2%)			
Total Bid Amount			

Accompanying this Bid Proposal is cash, certified check or bid bond payable to the City Finance Director, this being the amount not less than five percent (5%) of the total bid including sales tax if applicable, based upon the above price according to the conditions of the Notice to Bidders and Special Provisions. If this Bid Proposal is accepted by the City, and the undersigned fails to execute a satisfactory contract and payment and performance contract bond, as stated in contract attached, then the City may, at its option, determine that the undersigned has abandoned the contract and thereupon this contract shall be null and void, and the security accompanying this Bid Proposal shall be forfeited to the City. Otherwise the security accompanying this proposal shall be returned to the undersigned.

Dated this _____day of _____, 2026

By signing this Bid Proposal I duly swear that this bid herewith submitted is a genuine and not a sham or collusive bid, or made in the interest or on behalf of any person not therein named; and I further say that I have not directly or indirectly induced or solicited any bidder on the above work or supplies to put in a sham bid, or any other person or corporation to refrain from bidding; and that I have not in any manner sought collusion to secure to myself an advantage over any other bidder or bidders.

By signing this bid I acknowledge receipt of all Addenda (if any) and I acknowledge that I have verified this information by checking on the City's website for any Addenda that have been issued.

Submitted by:

Name of Bidder: _____

Address of Bidder: _____

Phone: _____ Fax: _____

Email: _____

Signature of Authorized Agent: _____

Print Name of Authorized Agent: _____

Contractor UBI Number: _____

Employment Security Department Number: _____

STATE OF WASHINGTON }
ss
COUNTY OF }

I CERTIFY that I know or have satisfactory evidence that _____, signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the _____ of _____ to be the free and voluntary act of such party for the uses and purposes mentioned in the instrument.

_____
DATED

(Seal or Stamp) _____
SIGNATURE OF NOTARY PUBLIC

_____
PRINTED NAME

Notary Public
_____
TITLE

_____
MY APPOINTMENT EXPIRES

BID BOND

(City Form only, No other Bid Bond will be accepted)

KNOW ALL MEN BY THESE PRESENTS:

That we _____

_____, as Principal, and _____

_____, as Surety, are held and firmly bound unto the CITY OF BELLINGHAM as Obligee, in the penal sum at least equal to FIVE PERCENT (5%) OF THE TOTAL AMOUNT OF THE BID for the payment of which the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by these presents.

The condition of the obligation is such that if the Obligee shall make any award to the Principal of _____

_____

according to the terms of the proposal or bid made by the Principal therefore, and the Principal shall duly make and enter into a contract with the Obligee in accordance with the terms of said proposal or bid and award and shall give bond for the faithful performance thereof, with Surety or Sureties approved by the Obligee; or if the Principal shall, in case of failure so to do, pay and forfeit to the Obligee the penal amount of the deposit specified in the call for bid, then this obligation shall be null and void; otherwise it shall be and remain in full force and effect and the surety shall forthwith pay and forfeit to the Obligee, as penalty and liquidated damages, the amount of this bond.

SIGNED, SEALED and **DATED** this _____ day of _____, 2026.

_____

Principal

_____

Surety

_____, 2026

BID DEPOSIT

Attached is a deposit in the form of a certified check, cashier's check, or cash in an amount at least equal to five percent (5%) of the total bid.

The condition of this obligation is that if the City of Bellingham (the "City") shall make an award to the Principal for

POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194
(title of Project)

according to bid or proposal made by the Principal, and the Principal enters into a contract with the City in accordance therewith and provides the City with a bond for the faithful performance thereof, with Surety or Sureties approved by the City, the attached Bid Bond Deposit shall be returned to the Principal. Alternatively, if the Principal, after submitting a bid for the above named project, is awarded the Contract and fails to provide a performance bond acceptable to the City, Principal shall forfeit to the City the penal amount of the Bid Deposit.

SIGNED, SEALED and **DATED** this _____ day of _____, 2026.

_____
Principal (Signature)

_____
Company Name

_____
Address

_____
City/State

SUBCONTRACTOR LISTING FORM

Prepared in compliance with RCW 39.30.060

To be Submitted with Bid

Project: POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194

At the published bid submittal time, the bidder shall submit the names and license numbers of the licensed subcontractors with whom the bidder, if awarded the contract, will directly subcontract for performance of the work of: heating, ventilation and air conditioning (HVAC); plumbing, as described in Chapter 18.106 RCW; and electrical, as described in Chapter 19.28 RCW. Alternatively, the bidder may name itself for the work if it is licensed to perform the work for which it has named itself.

In addition, at the published bid submittal time, or within 48 hours after the published bid submittal time, the bidder shall submit the names of the subcontractors with whom the bidder, if awarded the contract, will directly subcontract for performance of the work of structural steel installation and rebar installation. Alternatively, the bidder may name itself for the work.

The bidder shall not list more than one subcontractor for each category of work identified, unless subcontractors vary with bid alternates, in which case the bidder must indicate which subcontractor will be used for which alternate.

Failure of the bidder to submit, within the required time frames, the names of such subcontractors or to name itself for any such work that it is self-performing, will render the bidder's bid nonresponsive and, therefore, void.

To the extent the Project includes one or more categories of work referenced in RCW 39.30.060, and the bidder has not listed a subcontractor or itself for such work, the bidder certifies that the work will be performed by a lower tier subcontractor who will not contract directly with the bidder.

Work	**Subcontractor Name*** (List bidder's name if work will be self-performed.)	**License Number** (if required)
HVAC		
Plumbing		
Electrical		
Structural Steel Installation		
Rebar Installation		

* List "N/A" or leave blank if project does not involve such work.

The undersigned certifies that the information provided by bidder in the subcontractor listing form is true and correct to the best of his or her knowledge and belief.

_____ _____

Signature Date

_____ _____

Print Signatory's Name Bidder Name

CONTRACT FORMS
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORK AGREEMENT
POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194

The **CITY OF BELLINGHAM**, a first-class municipal corporation of the State of Washington (hereinafter the "City"), and _____, a licensed contractor authorized to do business in the State of Washington, (hereinafter "Contractor"), hereby agree to enter into this Public Works Agreement ("Agreement") under the following terms and conditions in recognition of the mutual covenants and consideration contained herein.

I. THE PROJECT: Contractor shall do all work and furnish all labor, tools, materials, and equipment for POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194 (the "Project") in accordance with the Contract, which includes this Agreement, Contractor's Bid Proposal, Contract Plans, Contract Provisions, Standard Specifications for Road, Bridge and Municipal Construction, most recent Edition, issued by the Washington State Department of Transportation ("Standard Specifications"), Addenda, and Change Orders (if any).

II. GENERAL REQUIREMENTS: The General Requirements of this Contract are set forth in Division 1 of the Standard Specifications, modified or supplemented as follows:

A. Definitions and Terms

1. All capitalized terms in this Agreement shall have the meaning ascribed to them in the Standard Specifications, unless otherwise defined herein.

2. Where the terms "Contract Form" or "Agreement Form" are used in the Standard Specifications, they shall be construed to mean this Agreement.

3. Where the terms "Washington State Transportation Commission", "State Department of Transportation", “Contracting Agency”, or variations of same are used in the Standard Specifications, they shall be construed to mean "City of Bellingham" or "Owner".

4. Where the terms "Secretary of Transportation" or "Secretary" are used in the Standard Specifications, the terms shall be construed to mean the duly authorized representative of the City.

B. Project Managers: The term "Engineer" is understood to be the City's Project Manager, who is the City's representative to the Contractor for all purposes under this Contract. The City designates Stephen Day, P.E. as its Project Manager. Contractor designates
as its Project Manager, who is Contractor's representative to the City for all purposes under this Contract.

C. Licenses: Contractor must possess a Bellingham business registration prior to bid award and continuing throughout the duration of the Project. Additionally, by executing this Agreement, Contractor certifies it has all other applicable state and local licenses and has not been debarred from public contracting by either Washington State or the United States Government.

D. Nondiscrimination: Contractor shall comply with all applicable Federal, State and local non-discrimination laws and regulations in effect at the time this Agreement is executed.

E. Taxes: Contractor is responsible for payment of all applicable taxes, including state sales tax on those projects subject to it. All taxes, including applicable State Sales Taxes, are deemed included in the Contractor's invoices.

F. Payment and Performance Contract Bond:

1. *Requirement*. Contractor shall provide a Payment and Performance Contract Bond, in the form attached hereto, as specified in Section 1-03.4 of the Standard Specifications.

2. *Exception*. On contracts of one hundred fifty thousand ($150,000) or less, at the Contractor's option, the City will, in lieu of Payment and Performance Contract Bond, withhold retainage of ten percent (10%) of the Contract price until releasable under RCW 39.08.010. If Contractor does not submit a Payment and Performance Contract Bond to the City concurrently with the signed Agreement for projects of one hundred fifty thousand dollars ($150,000) or less, Contractor agrees that the City may hold retainage of ten percent (10%) in the manner selected by Contractor on the attached Retainage Investment Option form.

G. Insurance: The insurance requirements for this Contract are contained in Section 1.07.18 of the Standard Specifications.

H. Governing Law and Venue: This Contract and all provisions hereof shall be interpreted in accordance with the laws of the State of Washington in effect on the date of execution of this Agreement without recourse to any principle of Conflicts of Laws. The Superior Court of Whatcom County, Washington, shall have exclusive jurisdiction and venue over any legal action arising under this Contract, except if jurisdiction lies solely in federal court, in which case the U.S. District Court for Western District of Washington shall be the exclusive venue.

III. PAYMENT, PREVAILING WAGES AND RETAINAGE:

A. Payment

1. This is a lump sum contract. The total amount to be paid to Contractor for the work provided herein is $_____, which consists of a contract price of $_____ and sales tax of $_____.

2. Contractor will be paid pursuant to the Contract's terms, including Section 1-09.9 of the Standard Specifications. Payments will only be made for work completed, labor performed, and materials furnished in accordance with the Contract and shall represent the value of the work completed subject to any lawful deductions such as retainage, tax or as otherwise authorized. Payment does not constitute final acceptance of work performed or materials used therein. A final application for payment shall be prepared upon completion of the work, satisfaction of test requirements and fulfillment of the Contract. Any invoices submitted by Contractor must be approved by the Project Manager prior to payment. No final payment shall be made until the project is accepted by the City.

B. Prevailing Wages: Prior to any payment hereunder, Contractor is responsible for complying with applicable Washington State Department of Labor and Industries and Department of Revenue requirements and procedures, including but not limited to prevailing wage requirements of Chapter 39.12 RCW. This includes obtaining and timely filing of intent to Pay Prevailing Wages, Affidavit of Wages Paid, Notice of Completion of Public Work Contract, and any other required documents.

C. Retainage: Retainage will be administered in accordance with Chapter 60.28 RCW and the Standard Specifications.

IV. TIME FOR COMPLETION; SCOPE OF WORK:

A. **Time for Completion**: Contractor shall begin work within ten business days of Notice to Proceed and shall complete work within 450 working days

B. **Scope of Work**: Construction of Area 440 Sludge Storage Tanks and Odor Control System, and installation of new sludge pumps and sump pumps and associated equipment, instruments and piping in the existing Area 420 and 530. Structural modifications to existing building in Area 420 for new room separation and entrances. Demolition of existing Chlorine Building, demolition of portions of the structure, equipment and piping in Areas 420 and 530 to accommodate new equipment and structural features. Excavation, shoring, dewatering, and pile installation required for new construction in Area 440. Demolition and replacement of RAS pump discharge and header piping and two pumps, demolition and replacement of WAS pumps, installation of secondary clarifier dewatering pump and discharge piping, and temporary piping to accommodate the RAS work in Area 340. Work includes associated electrical equipment installation, heating, ventilation and air conditioning improvements, repair and reconstruction of existing structures affected by the Work, and incidentals for complete and usable facility, including commissioning of all installed work. See Exhibit "A" attached and incorporated herein by this reference.

EXECUTED, this _____ day of _____, 2026, for **CONTRACTOR** , by:

Sign: _____

Print: _____

Title: _____

EXECUTED, this _____ day of _____, 2026, for the **CITY OF BELLINGHAM** by:

Departmental Approval:

_____
Mayor

_____
Department Head

Attest:

Approved as to Form:

_____
Finance Director

_____
Office of the City Attorney

STATE OF WASHINGTON

COUNTY OF

} **ss**

I CERTIFY that I know or have satisfactory evidence that _____, signed this instrument, on oath stated that he/she/they was/were authorized to execute the instrument and acknowledged it as the _____ of _____ to be the free and voluntary act of such party for the uses and purposes mentioned in the instrument.

_____
DATED

_____
(Seal or Stamp) SIGNATURE OF NOTARY PUBLIC

_____
PRINTED NAME

Notary Public
_____
TITLE

_____
MY APPOINTMENT EXPIRES

PAYMENT AND PERFORMANCE CONTRACT BOND
to the CITY OF BELLINGHAM, WASHINGTON

THE CITY OF BELLINGHAM, WASHINGTON (the "City") has awarded to _____ _____ ("Principal"), a contract for the construction of the project designated as POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194 ("Contract"), and said Principal is required to furnish a payment and performance bond in accordance with RCW 39.08 and, where applicable, RCW 60.28.

The Principal and _____ ("Surety), a corporation organized under the laws of the State of _____ and licensed to do business in the State of Washington as surety, are jointly and severally held and firmly bound to the City in the sum of _____ _____US Dollars ($_____), subject to the provisions herein.

THE CONDITIONS OF THIS BOND ARE SUCH THAT, if the said Principal faithfully performs all of the provisions of the Contract in the manner and within the time therein set forth, or within such extension of time as may be granted under the Contract (notice of which extension being hereby waived by the Surety), and shall pay all laborers, mechanics, subcontractors and material suppliers, and all persons who supply said principal or subcontractors with provisions and supplies for the carrying on of the Contract work, and shall hold the City harmless from any loss or damage occasioned to any person or property by reason of any carelessness or negligence of the Principal, or any subcontractor in the performance of the Contract work, and shall hold the City harmless from any loss or damage occasioned to any person or property by reason of any carelessness or negligence of the Principal, or any subcontractor in the performance of the Contract work, and shall indemnify and hold harmless from any direct or indirect damage or expense by reason or failure of performance as specified in the Contract or from defects appearing or developing in the material or workmanship provided or performed under the Contract, then and in that event this obligation shall be void; but otherwise it shall be and remain in full force and effect until, at a minimum, claims filed in compliance with Chapter 39.08 RCW are resolved and all other conditions set forth herein are satisfied.

PROVIDED FURTHER, that if said Contract is a public improvement contract involving the construction, alteration, repair, or improvement of any highway, road, or street funded in whole or in part by federal transportation funds, then an additional condition of this bond shall be that this bond secures full payment to the State of Washington, including the departments of Revenue, Employment Security, and Labor and Industries, with respect to taxes imposed pursuant to Titles 50, 51, and 82 RCW which may be due.

THE SURETY, FOR VALUE RECEIVED, FURTHER AGREES THAT no change, extension of time, alteration or addition to the terms of the Contract, the specifications accompanying the Contract, or to the work to be performed under the Contract shall in any way

affect its obligation on this bond, and waives notice of any change, extension of time, alteration or addition to the terms of the Contract or the work performed. The Surety agrees that modification and changes to the terms and conditions of the Contract that increase the total amount to be paid the Principal shall automatically increase the obligation of the Surety on this bond and notice to Surety is not required for such increased obligation.

THE SURETY ACKNOLWEDGES that the City will execute the Contract after the date of execution of the power of attorney attached to this bond, and the Surety further represents that the power of attorney will be valid on the date of Contract execution.

PRINCIPAL	**SURETY**
_____	_____
Sign	Sign
_____	_____
Print Name, Title	Print Name, Title
_____	_____
Date of Execution	Date of Execution and Seal

Name, address, and telephone of local office/agent of Surety is:

APPROVED AND ACCEPTED this _____day of _____, 20__ for the **CITY OF BELLINGHAM** by:

Departmental Approval:

_____	_____
Mayor	Director
Attest:	Approved as to Form:
_____	_____
Finance Director	Office of the City Attorney

RETAINAGE INVESTMENT OPTION

Contractor: _____ Project Name: POST POINT SLUDGE TANK REPLACEMENT PROJECT

Date: _____ Project Number: EU194

Pursuant to RCW 60.28.010, as amended, you may exercise an option as to how retainage under this contract will be invested. Please complete and sign this form indicating your preference. If you fail to do so, the City will deposit the funds in a Guarantee Deposit account, and you will miss the benefit of any interest earned. Select one of the following options:

☐ 1. **Savings Account:** Money will be placed in an interest-bearing account. The interest will be paid to you directly, rather than kept on deposit. Please state the name of your bank. _____

☐ 2. **Escrow/Investments:** The City will deliver retainage checks to a selected bank, pursuant to an escrow agreement. The bank will then invest the funds in securities or bonds selected by you, and interest will be paid to you as it accrues.

Preferred bank: _____

Securities/bonds: _____

☐ 3. **Guarantee Deposit:** Retainage will be deposited in a manner selected by the City. No interest is payable to the Contractor.

Retainage will be administered in accordance with Chapter 60.28 RCW and the Standard Specifications.

State law allows for limited early release of retainage in certain circumstances.

Contractor acknowledges that any Escrow Account Agreement or Savings Account Agreement executed by Contractor will be publicly available on the City's website along with other Contract Documents for this Project.

_____

Contractor's Signature

_____

Title

ESCROW AGREEMENT

TO BANK:_____ ESCROW NO.:_____

BANK'S ADDRESS: _____

_____

AGENCY: CITY OF BELLINGHAM
210 Lottie Street, Bellingham, Washington, 98225

CONTRACT NO.: _____

PROJECT TITLE: POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194

The estimated completion date of contract is: _____

The undersigned,_____, herein referred to as the CONTRACTOR, has directed the CITY OF BELLINGHAM, Washington, hereinafter referred to as the AGENCY, to deliver to you its warrants which shall be payable to you and the CONTRACTOR jointly. Such warrants are to be held and disposed of by you in accordance with the following instructions and upon the terms and conditions hereinafter set forth.

INSTRUCTIONS

1. Warrants or checks made payable to you and the CONTRACTOR jointly upon delivery to you shall be endorsed by you and forwarded for collection. The moneys will then be used by you to purchase, as directed by the CONTRACTOR, bonds or other securities chosen by the CONTRACTOR and approved by the AGENCY. Attached is a list of such bonds, or other securities approved by the AGENCY. Other bonds or securities, except stocks may be selected by the CONTRACTOR, subject to express written approval of the AGENCY. Purchase of such bonds or other securities shall be in a form which shall allow you alone to reconvert such bonds or other securities into money if you are required to do so by the AGENCY as provided in Paragraph 4 of this Escrow Agreement.

2. When and as interest on the securities held by you pursuant to this agreement accrues and is paid, you shall collect such interest and forward it to the CONTRACTOR at its address designated below unless otherwise directed by the CONTRACTOR.

3. You are not authorized to deliver to the CONTRACTOR all or any part of the securities held by you pursuant to this agreement (or any moneys derived from the sale of such securities, or the negotiation of the AGENCY'S warrants) except in accordance with written instructions from the AGENCY. Compliance with such instructions shall relieve you of any further liability related thereto.

4. In the event the AGENCY orders you to do so in writing, you shall, within thirty-five (35) days' of receipt of such order, reconvert into money the securities held by you pursuant to this agreement and return such money together with any other moneys held by you hereunder, to the AGENCY.

5. The CONTRACTOR agrees to pay you as compensation for your services hereunder as follows:

   Payment of all fees shall be the sole responsibility of the CONTRACTOR and shall not be deducted from any property placed with you pursuant to this agreement until and unless the AGENCY directs the release to the CONTRACTOR of the securities and moneys held

hereunder whereupon you shall be granted a first lien upon such property released and shall be entitled to reimburse yourself from such property for the entire amount of your fees as provided for herein above. In the event that you are made a party to any litigation with respect to the property held by you hereunder, or in the event that the conditions of this escrow are not promptly fulfilled or that you are required to render any service not provided for in these instructions, or that there is any assignment of the interests of this escrow or any modification hereof, you shall be entitled to reasonable compensation for such extraordinary services from the CONTRACTOR and reimbursement from the CONTRACTOR for all costs and expenses, including attorney fees occasioned by such default, delay, controversy or litigation.

6. This agreement shall not be binding until executed by the CONTRACTOR and the AGENCY and accepted by you.

7. This instrument contains the entire agreement between you, the CONTRACTOR and the AGENCY with respect to this escrow and you are not a party to nor bound by any instrument or agreement other than this; you shall not be required to take notice of any default or any other matter nor be bound by nor required to give notice or demand, nor required to take any action whatever except as herein expressly provided; you shall not be liable for any loss or damage not caused by your own negligence or willful misconduct.

The foregoing provisions shall be binding upon the assigns, successors, personal representatives and heir of the parties hereto.

_____	CITY OF BELLINGHAM
Contractor	*Agency*
By: _____	By: _____
	Finance Director
_____	
Title	Date: _____
Address: _____	
_____	
_____	
_____	
Date: _____	

The above escrow agreement and instructions received and accepted this _____day of _____, 2026.

Bank Name

_____

Authorized Officer

_____

SECURITIES AUTHORIZED BY AGENCY

1. Bills, certificates, notes or bonds of the United States;
2. Other obligations of the United States or its agencies;
3. Obligations of any corporation wholly owned by the government of the United States;
4. Indebtedness of the Federal Nation Mortgage Association; and
5. Time deposits in commercial banks.

SAVINGS ACCOUNT AGREEMENT

TO BANK:_____ SAVINGS ACCT NO.:_____

BANK'S ADDRESS: _____

_____

AGENCY: CITY OF BELLINGHAM
210 Lottie Street, Bellingham, Washington, 98225

CONTRACT NO.: _____

PROJECT TITLE: POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194

The estimated completion date of contract is: _____

The undersigned, _____, herein referred to as the CONTRACTOR, has directed the CITY OF BELLINGHAM, Washington, hereinafter referred to as the AGENCY, to deliver to you its warrants which shall be payable to you and the CONTRACTOR jointly. Such warrants are to be held and disposed of by you in accordance with the following instructions and upon the terms and conditions hereinafter set forth.

INSTRUCTIONS

1. Warrants or checks made payable to you and the CONTRACTOR jointly upon delivery to you shall be endorsed by you and forwarded for collection. The moneys will then be placed by you in an interest-bearing savings account.

2. When and as interest on the savings account accrues and is paid, you shall collect such interest and forward it to the CONTRACTOR at its address designated below unless otherwise directed by the CONTRACTOR.

3. You are not authorized to deliver to the CONTRACTOR all or any part of the principal held by you pursuant to this agreement, except in accordance with written instructions from the AGENCY. Compliance with such instructions shall relieve you of any further liability related thereto.

4. The CONTRACTOR agrees to pay you as compensation for your services hereunder as follows:

   Payment of all fees shall be the sole responsibility of the CONTRACTOR and shall not be deducted from any moneys placed with you pursuant to this agreement until and unless the AGENCY directs the release to the CONTRACTOR, whereupon you shall be granted a first lien upon such moneys released and shall be entitled to reimburse yourself from such moneys for the entire amount of your fees as provided for herein above. In the event that you are made a party to any litigation with respect to the moneys held by you hereunder, or in the event that the conditions of this agreement are not promptly fulfilled, or that you are required to render any service not provided for in these instructions, or that there is any assignment of the interests of this agreement, or any modification hereof, you shall be entitled to reasonable compensation for such extraordinary services for the CONTRACTOR and reimbursement from the CONTRACTOR for all costs and expenses, including attorney fees occasioned by such default, delay, controversy or litigation.

5. This agreement shall not be binding until executed by the CONTRACTOR and the AGENCY and accepted by you.

6. This instrument contains the entire agreement between you, the CONTRACTOR and the AGENCY. You are not a party to nor bound by any instrument or agreement other than this. You shall not be required to take notice of any default or any other matter nor be bound by nor required to give notice or demand, nor required to take any action whatever except as herein expressly provided. You shall not be liable for any loss or damage not caused by your own negligence or willful misconduct.

7. The foregoing provisions shall be binding upon the assigns, successors, personal representatives and heir of the parties hereto.

_____	CITY OF BELLINGHAM
Contractor	*Agency*
By: _____	By: _____
	Finance Director
_____	
Title	Date: _____
Address: _____	
_____	
_____	
_____	
Date: _____	

The above savings account agreement and instructions received and accepted this _____day of _____, 2026.

Bank Name

_____

Authorized Officer

_____

SPECIAL PROVISIONS
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

(January 4, 2024 APWA GSP, Option A)

The work on this project shall be accomplished in accordance with the *Standard Specifications for Road, Bridge and Municipal Construction*, 2026 edition, as issued by the Washington State Department of Transportation (WSDOT) and the American Public Works Association (APWA), Washington State Chapter (hereafter "Standard Specifications"). The Standard Specifications, as modified or supplemented by these Special Provisions, all of which are made a part of the Contract Documents, shall govern all of the Work.

These Special Provisions are made up of both General Special Provisions (GSPs) from various sources, which may have project-specific fill-ins; and project-specific Special Provisions. Each Provision either supplements, modifies, or replaces the comparable Standard Specification, or is a new Provision. The deletion, amendment, alteration, or addition to any subsection or portion of the Standard Specifications is meant to pertain only to that particular portion of the section, and in no way should it be interpreted that the balance of the section does not apply.

The GSPs are labeled under the headers of each GSP, with the effective date of the GSP and its source. For example:

(March 8, 2013 APWA GSP)
(April 1, 2013 WSDOT GSP)
(May 1, 2013 City of Bellingham Special Provision)

Project specific special provisions are labeled without a date as such:
(*****)

Also incorporated into the Contract Documents by reference are:

- *Manual on Uniform Traffic Control Devices for Streets and Highways*, currently adopted edition, with Washington State modifications, if any
- *Standard Plans for Road, Bridge and Municipal Construction*, WSDOT Manual M21-01, current edition
- City of Bellingham Development and Design Standards, current edition (https://cob.org/gov/rules/standards)

Contractor shall obtain copies of these publications, at Contractor's own expense.

DIVISION 1
GENERAL REQUIREMENTS

Description of Work
(March 13, 1995, Option B)

This Contract provides for the improvement of ***Construction of Area 440 Sludge Storage Tanks and Odor Control System, and installation of new sludge pumps and sump pumps and associated equipment, instruments and piping in the existing Area 420 and 530. Structural modifications to existing building in Area 420 for new room separation and entrances. Demolition of existing Chlorine Building, demolition of portions of the structure, equipment and piping in Areas 420 and 530 to accommodate new equipment and structural features. Excavation, shoring, dewatering, and pile installation required for new construction in Area 440. Demolition and replacement of RAS pump discharge and header piping and two pumps, demolition and replacement of WAS pumps, installation of secondary clarifier dewatering pump and discharge piping, and temporary piping to accommodate the RAS work in Area 340. Work includes associated electrical equipment installation, heating, ventilation and air conditioning improvements, repair and reconstruction of existing structures affected by the Work, and incidentals for complete and usable facility, including commissioning of all installed work.***

1-01.3 Definitions
(January 19, 2022 APWA GSP)

Delete the heading **Completion Dates** and the three paragraphs that follow it, and replace them with the following:

Dates

Bid Opening Date
The date on which the Contracting Agency publicly opens and reads the Bids.

Award Date
The date of the formal decision of the Contracting Agency to accept the lowest responsible and responsive Bidder for the Work.

Contract Execution Date
The date the Contracting Agency officially binds the Agency to the Contract.

Notice to Proceed Date
The date stated in the Notice to Proceed on which the Contract time begins.

Substantial Completion Date
The day the Engineer determines the Contracting Agency has full and unrestricted use and benefit of the facilities, both from the operational and safety standpoint, any remaining traffic disruptions will be rare and brief, and only minor incidental work, replacement of temporary substitute facilities, plant establishment periods, or correction or repair remains for the Physical Completion of the total Contract.

Physical Completion Date
The day all of the Work is physically completed on the project. All documentation required by the Contract and required by law does not necessarily need to be furnished by the Contractor by this date.

Completion Date
The day all the Work specified in the Contract is completed and all the obligations of the Contractor under the contract are fulfilled by the Contractor. All documentation required by the Contract and required by law must be furnished by the Contractor before establishment of this date.

Final Acceptance Date
The date on which the Contracting Agency accepts the Work is complete.

Supplement this Section with the following:

All references in the Standard Specifications or WSDOT General Special Provisions, to the terms “Department of Transportation”, “Washington State Transportation Commission”, “Commission”, “Secretary of Transportation”, “Secretary”, “Headquarters”, and “State Treasurer” shall be revised to read “Contracting Agency”.

All references to the terms “State” or “state” shall be revised to read “Contracting Agency” unless the reference is to an administrative agency of the State of Washington, a State statute or regulation, or the context reasonably indicates otherwise.

All references to “State Materials Laboratory” shall be revised to read “Contracting Agency designated location”.

All references to “final contract voucher certification” shall be interpreted to mean the Contracting Agency form(s) by which final payment is authorized, and final completion and acceptance granted.

Additive
A supplemental unit of work or group of bid items, identified separately in the Bid Proposal, which may, at the discretion of the Contracting Agency, be awarded in addition to the base bid.

Alternate
One of two or more units of work or groups of bid items, identified separately in the Bid Proposal, from which the Contracting Agency may make a choice between different methods or material of construction for performing the same work.

Business Day
A business day is any day from Monday through Friday except holidays as listed in Section 1-08.5.

Contract Bond
The definition in the Standard Specifications for “Contract Bond” applies to whatever bond form(s) are required by the Contract Documents, which may be a combination of a Payment Bond and a Performance Bond.

Contract Documents
See definition for “Contract”.

Contract Time
The period of time established by the terms and conditions of the Contract within which the Work must be physically completed.

Notice of Award
The written notice from the Contracting Agency to the successful Bidder signifying the Contracting Agency’s acceptance of the Bid Proposal.

Notice to Proceed
The written notice from the Contracting Agency or Engineer to the Contractor authorizing and directing the Contractor to proceed with the Work and establishing the date on which the Contract time begins.

Traffic
Both vehicular and non-vehicular traffic, such as pedestrians, bicyclists, wheelchairs, and equestrian traffic.

1-02 BID PROCEDURES AND CONDITIONS

1-02.1 Prequalification of Bidders

Delete this section and replace it with the following:

1-02.1 Qualifications of Bidder
(February 17, 2026 APWA GSP, Option A)

Before award of a public works contract, a Bidder must meet at least the minimum qualifications of RCW 39.04.350(1) to be considered a responsible bidder and qualified to be awarded a public works project.

1-02.2 Plans and Specifications
(June 27, 2011 APWA GSP)

Delete this section and replace it with the following:

Information as to where Bid Documents can be obtained or reviewed can be found in the Call for Bids (Advertisement for Bids) for the work.

After award of the contract, plans and specifications will be issued to the Contractor at no cost as detailed below:

To Prime Contractor	No. of Sets	Basis of Distribution
Reduced plans (11" x 17")	***3***	Electronic copies provided. Will furnish paper copies upon request.
Contract Provisions	***3***	Electronic copies provided. Will furnish paper copies upon request.
Large plans (e.g., 22" x 34")	***1***	Electronic copies provided. Will furnish paper copies upon request.

Additional plans and Contract Provisions may be obtained by the Contractor from the source stated in the Call for Bids, at the Contractor's own expense.

1-02.4(1) General
(December 30, 2022 APWA GSP Option B)

The first sentence of the ninth paragraph, beginning with "Prospective Bidder desiring…", is revised to read:

Prospective Bidders desiring an explanation or interpretation of the Bid Documents, shall request the explanation or interpretation in writing by close of business ***5*** business days preceding the bid opening to allow a written reply to reach all prospective Bidders before the submission of their Bids.

1-02.5 Proposal Forms

(February 17, 2026 APWA GSP)

Delete this section and replace it with the following:

The Proposal Form will identify the project and its location and describe the work. It will also list estimated quantities, units of measurement, the items of work, and the materials to be furnished at the unit bid prices. The bidder shall complete spaces on the proposal form that call for, but are not limited to, unit prices; extensions; summations; the total bid amount; signatures; date; and, where applicable, retail sales taxes and acknowledgment of addenda; the bidder's name, address, telephone number, and signature. Bids shall be in legible figures (not words) written in ink or typed and expressed in U.S. dollars. The required certifications are included as part of the Proposal Form.

The Contracting Agency reserves the right to arrange the proposal forms with alternates and additives, if such be to the advantage of the Contracting Agency. The bidder shall bid on all alternates and additives set forth in the Proposal Form unless otherwise specified.

1-02.6 Preparation of Proposal

(February 17, 2026 APWA GSP, Option B)

Revise the fourth paragraph to read:

Subcontractor's List

The Bidder shall submit with the Bid the completed Subcontractor List included in the Contracting Agency Proposal Package. If a Subcontractor List Form is not included in the package, use DOT Form 271-015LP. The Form shall contain the following:

1. Subcontractors who will perform the Work of structural steel installation, rebar installation, heating, ventilation, air conditioning, and plumbing as described in RCW 18.106 and electrical as described in RCW 19.28.

2. The Work those subcontractors will perform on the Contract as described in RCW 39.04.350(1)(b-g), and

3. No more than one subcontractor for each category of Work identified, except, when subcontractors vary with Bid alternates, in which case the Bidder shall identify which subcontractor will be used for which alternate.

1-02.7 Bid Deposit

(February 17, 2026 APWA GSP)

Revise the third sentence of the first paragraph to read:

For projects that are selected by the Contracting Agency to be Bid electronically, the proposal bond may be in either a physical format, or an electronic format via ***Portable Document Format (PDF)***.

Supplement this section with the following:

Bid bonds shall contain the following:

1. Contracting Agency-assigned number for the project;
2. Name of the project;
3. The Contracting Agency named as obligee;

4. The amount of the bid bond stated either as a dollar figure or as a percentage which represents five percent of the maximum bid amount that could be awarded;
5. Signature of the bidder's officer empowered to sign official statements. The signature of the person authorized to submit the bid should agree with the signature on the bond, and the title of the person must accompany the said signature;
6. The signature of the surety's officer empowered to sign the bond and the power of attorney.

If so stated in the Contract Provisions, bidder must use the bond form included in the Contract Provisions.

If so stated in the Contract Provisions, cash will not be accepted for a bid deposit.

1-02.9 Delivery of Proposal
(November 21, 2025 APWA GSP, Option A)

Delete this section and replace it with the following:

GENERAL

Each Proposal shall be submitted in a sealed envelope, with the Project Name and Project Number as stated in the Call for Bids clearly marked on the outside of the envelope, or as otherwise required in the Bid Documents, to ensure proper handling and delivery.

Proposals that are received as required will be publicly opened and read as specified in Section 1-02.12. The Contracting Agency will not open or consider any Bid Proposal that is received after the time specified in the Call for Bids for receipt of Bid Proposals or received in a location other than that specified in the Call for Bids. The Contracting Agency will not open or consider any "Supplemental Information" that is received after the time specified, or received in a location other than that specified in the Call for Bids.

If an emergency or unanticipated event interrupts normal work processes of the Contracting Agency so that Proposals cannot be received at the office designated for receipt of bids as specified in Section 1-02.12 the time specified for receipt of the Proposal will be deemed to be extended to the same time of day specified in the solicitation on the first work day on which the normal work processes of the Contracting Agency resume.

Supplemental bid information submitted after the Proposal submittal but within 48 hours of the time and date the Proposal is due, shall be submitted in a sealed envelope labeled the same as for the Proposal, with "Supplemental Information" added.

All other information required to be submitted with the Bid Proposal must be submitted with the Bid Proposal itself, at the time stated in the Call for Bids.

1-02.10 Withdrawing, Revising, or Supplementing Proposal
(February 17, 2026 APWA GSP)

Delete this section, and replace it with the following:

After submitting a physical or an electronic bid, if allowed under 1-02.9, Bid Proposal to the Contracting Agency, the Bidder may withdraw, revise, or supplement it if:

1. The Bidder submits a written request signed by an authorized person and physically delivers it to the place designated for receipt of Bid Proposals, if a physical Bid Proposal was submitted, or recalled electronically via electronic method described in 1-02.9 if an electronic Bid Proposal was submitted, and

2. The Contracting Agency receives the request before the time set for receipt of Bid Proposals, and
3. The revised or supplemented Bid Proposal (if any) is received by the Contracting Agency before the time set for receipt of Bid Proposals.

If the Bidder's request to withdraw, revise, or supplement its Bid Proposal is received before the time set for receipt of Bid Proposals, the Contracting Agency will return the unopened Proposal package to the Bidder. The Bidder must then submit the revised or supplemented package in its entirety. If the Bidder does not submit a revised or supplemented package before the time set for receipt of Bid Proposals, then its bid shall be considered withdrawn.

Late revised or supplemented Bid Proposals or late withdrawal requests will be date recorded by the Contracting Agency and returned unopened. Requests to withdraw, revise, or supplement a Bid Proposal may be submitted by the following methods:

1. In person.

1-02.13 Irregular Proposals
(July 15, 2026 APWA GSP)

Delete this Section and replace it with the following:

1. A Proposal will be considered irregular and will be rejected if:
   a. The Bidder is not prequalified when so required;
   b. The Bidder adds provisions reserving the right to reject or accept the Award, or enter into the Contract;
   c. A price per unit cannot be determined from the Bid Proposal;
   d. The Proposal form is not properly executed;
   e. The Bidder fails to submit or properly complete a subcontractor list as required in Section 1-02.6; or
   f. The Bid Proposal does not constitute a definite and unqualified offer to meet the material terms of the Bid invitation.

2. A Proposal may be considered irregular and may be rejected if:
   a. The Proposal does not include a unit price for every Bid item;
   b. Any of the unit prices are excessively unbalanced (either above or below the amount of a reasonable Bid) to the potential detriment of the Contracting Agency;
   c. The authorized Proposal Form furnished by the Contracting Agency is not used or is altered;
   d. The completed Proposal form contains unauthorized additions, deletions, alternate Bids, or conditions;
   e. Receipt of Addenda is not acknowledged;
   f. A member of a joint venture or partnership and the joint venture or partnership submit Proposals for the same project (in such an instance, both Bids may be rejected);
   g. The Bidder fails to submit the Bidder Questionnaire, if applicable, as required by Section 1-02.6, or if the documentation that is submitted fails to meet the requirements of the Special Provisions; or
   h. If Proposal form entries are not made in ink.

1-02.15 Pre Award Information

(CITY OF BELLINGHAM Special Provision)

Supplement this Section with the following:

Before work begins, the successful bidder must have a valid City of Bellingham Business Registration Certificate and will be subject to paying Bellingham business and occupation taxes. For additional information, call the Finance Department, (360) 778-8000. Direct any bidding questions to the Purchasing Office (360) 778-7750 and any technical questions to the Project Engineer (360) 778-7900.

After the bid award, but at least five days prior to commencing the work, the City may require the Contractor to submit the following information:

1. A satisfactory statement of costs for each major item of work included in the Bid Proposal which will be used as the basis for payment applications.,
2. A designation of the amount and type of work to be performed by the Contractor's own forces
3. A list of names of the subcontractors or other persons or organizations proposed for such portions of the work and an estimated employment profile of such subcontractor's forces. Subcontractors, employees, and other persons and organizations proposed by the Contractor and accepted by the Owner must be used on the work for which they were proposed and accepted and shall not be changed without the City's written approval.

1-03.4 Contract Bond

(July 23, 2015 APWA GSP)

Delete the first paragraph and replace it with the following:

The successful bidder shall provide executed payment and performance bond(s) for the full contract amount. The bond may be a combined payment and performance bond; or be separate payment and performance bonds. In the case of separate payment and performance bonds, each shall be for the full contract amount. The bond(s) shall:

1. Be on Contracting Agency-furnished form(s);
2. Be signed by an approved surety (or sureties) that:
   a. Is registered with the Washington State Insurance Commissioner, and
   b. Appears on the current Authorized Insurance List in the State of Washington published by the Office of the Insurance Commissioner,
3. Guarantee that the Contractor will perform and comply with all obligations, duties, and conditions under the Contract, including but not limited to the duty and obligation to indemnify, defend, and protect the Contracting Agency against all losses and claims related directly or indirectly from any failure:
   a. Of the Contractor (or any of the employees, subcontractors, or lower tier subcontractors of the Contractor) to faithfully perform and comply with all contract obligations, conditions, and duties, or
   b. Of the Contractor (or the subcontractors or lower tier subcontractors of the Contractor) to pay all laborers, mechanics, subcontractors, lower tier subcontractors, material person, or any other person who provides supplies or provisions for carrying out the work;
4. Be conditioned upon the payment of taxes, increases, and penalties incurred on the project under titles 50, 51, and 82 RCW; and
5. Be accompanied by a power of attorney for the Surety's officer empowered to sign the bond; and

6. Be signed by an officer of the Contractor empowered to sign official statements (sole proprietor or partner). If the Contractor is a corporation, the bond(s) must be signed by the president or vice president, unless accompanied by written proof of the authority of the individual signing the bond(s) to bind the corporation (i.e., corporate resolution, power of attorney, or a letter to such effect signed by the president or vice president).

1-03.7 Judicial Review
(December 30, 2022 APWA GSP)

Revise this section to read:

All decisions made by the Contracting Agency regarding the Award and execution of the Contract or Bid rejection shall be conclusive subject to the scope of judicial review permitted under Washington Law. Such review, if any, shall be timely filed in the Superior Court of the county where the Contracting Agency headquarters is located, provided that where an action is asserted against a county, RCW 36.01.050 shall control venue and jurisdiction.

1-04 SCOPE OF WORK

1-04.2 Coordination of Contract Documents, Plans, Special Provisions, Specifications, and Addenda
(December 30, 2022 APWA GSP)

Revise the second paragraph to read:

Any inconsistency in the parts of the contract shall be resolved by following this order of precedence (e.g., 1 presiding over 2, 2 over 3, 3 over 4, and so forth):

1. Addenda,
2. Proposal Form,
3. Special Provisions,
4. Contract Plans,
5. Standard Specifications,
6. Contracting Agency's Standard Plans or Details (if any), and
7. WSDOT Standard Plans for Road, Bridge, and Municipal Construction.

1-04.4 Changes
(January 19, 2022 APWA GSP)

The first two sentences of the last paragraph of Section 1-04.4 are deleted.

1-04.5 Procedure, Protest, and Dispute by the Contractor

1-04.5(1) Disputes
(******)
(CITY OF BELLINGHAM Special Provision)

Section 1-04.5(1) is supplemented with the following:

The bid proposal does not include the Bid item "Disputes Review Board". Once the Contractor has exhausted the process listed in Section 1-04.5, the Contractor shall comply with the formal certified claim process outlined in Section 1-09.11(2).

1-05.7 Nonconforming Work
(February 17, 2026 APWA GSP)

Supplement this section with the following:

The rights exercised under the provisions of this Section shall not diminish the Contracting Agency's right to pursue any other avenue for additional remedy or damages with respect to the Contractor's failure to perform the Work as required. The Engineer has the right to reject all or part of the Nonconforming Work, and the Engineer's decision is final and not subject to protest.

No additional contract time or compensation will be allowed when the Contracting Agency exercises their rights provided by this Section.

1-05.7(1) Identification of Nonconforming Work
Replace this section with the following:

The Contractor is responsible for quality control and shall identify all Nonconforming Work. The Contracting Agency may also identify Nonconforming Work. However, failure by the Contracting Agency to identify Nonconforming Work shall not relieve the Contractor from their responsibility for the quality of the Work, nor shall it constitute acceptance or approval of the Nonconforming Work.

1-05.7(2) Reporting of Nonconforming Work
Replace this section with the following:

The Contractor shall immediately report all Nonconforming Work to the Engineer and shall include any relevant information known for suggested remediation of Nonconforming Work.

When the Contracting Agency identifies Nonconforming Work, the Engineer will notify the Contractor in writing specifying a time when a remedy must be complete. If the Contractor fails to remedy Nonconforming Work within the time specified in a written notice from the Engineer, or fails to perform any part of the Work required by the Contract Documents, the Engineer may correct and remedy such Work as may be identified in the written notice.

1-05.7(3) Remediation of Nonconforming Work
Supplement this section with the following:

The Contractor shall be responsible and bear all costs for remediating Nonconforming Work.

If the Contracting Agency remedies Nonconforming Work after the specified time when a remedy was to be completed, by any means deemed necessary, direct and indirect costs incurred by the Contracting Agency attributable to correcting and remedying Nonconforming Work not corrected by the time provided in the notice, or Work the Contractor failed or refused to perform, shall be paid by the Contractor.

If the Contractor fails to comply with a written order to remedy what the Engineer determines to be an emergency situation, the Engineer may have the Nonconforming Work corrected immediately, have the Work removed and replaced, or have Work the Contractor refuses to perform completed by using Contracting Agency or other forces. An emergency situation is any situation when, in the opinion of the Engineer, a delay in its remedy could be potentially unsafe, or might cause risk of loss or damage to the public.

When costs are incurred by the Contracting Agency, payment will be deducted by the Engineer from monies due, or to become due, to the Contractor. Such direct and indirect

costs shall include in particular, but without limitation, compensation for additional professional services required, and compensation for removal, repair, replacement and/or correction of the Contractor's Nonconforming Work.

1-05.8 Project Communication (New Section)

(City of Bellingham Special Provision)

Supplement this section with the following:

1-05.8(1) Project Documentation

As defined, working drawings and submittals shall be considered the same terms and may be used interchangeably throughout the contract documents.

Submittals shall be made per Procore® Submittal Number and Revision, rather than per material. The Contractor shall be responsible for ensuring that each submittal includes cut sheets and/or other information for all pertinent materials necessary to complete the work for each Submittal Number. It is understood that producing submittals for each Submittal Number may require multiple submittals of common materials that are associated with more than one Submittal Number. The Contractor shall also be responsible for producing submittals that may only be associated with a Specification Section, not a particular Submittal Number.

The Contractor shall submit electronic copies of each submittal required by the Contract Documents through the Contracting Agency's cloud-based project management software, Procore (see Section 1-05.17), unless otherwise required elsewhere in the Contract Provisions. This includes, but is not limited to:

- Working Drawings
- Product Data
- Samples
- Reports
- Material Submittals (Ref. 1-06)
- Progress Schedules (Ref. 1-08.3)
- Guarantees/Warranties (Ref. 1-05.10)

Physical samples shall be delivered with a hardcopy transmittal of the Procore® submittal.

The Engineer will return reviewed submittals through the Procore® web-based project management software for the Contractor's use.

1-05.8(2) Submittal Schedule

In conformance with section 1-08.3, the progress schedule shall be submitted and reviewed prior to commencing any work. No delay claim shall be entertained for Contractor's failure to comply.

No claim will be allowed for damages or extension of time resulting from rejection of a submittal or the requirement of resubmittals as outlined by this section.

1-05.8(3) Submittal Procedures

Contractor submittals shall be in accordance with the following:

The Contractor shall thoroughly review each submittal for dimensions, quantities, and details of the material or item shown. The Contractor shall review each submittal and note any errors, omissions, or deviations with the Contract Documents. The Contractor shall accept full responsibility for the completeness of each submittal.

Each submittal shall have a unique number assigned to it (via Procore®). On each page, indicate the page number, and total number of pages in each submittal.

Each submittal shall indicate the following:

1. WSDOT form 350-071 Request for Approval of Material (RAM) coversheet
2. The intended use of the item in the work;
3. Clearly indicate only applicable items on any catalog cut sheets;
4. The current revision, issue number, and data shall be indicated on all drawings and other descriptive data.
5. Description of Submittal.
6. Related Specification Section and/or plan sheet.
7. Each material submittal shall clearly indicate the name and address of all suppliers, processors, distributors, and/or producers from which the Contractor directly purchased each material.
8. Each submittal shall be limited to one RAM page and shall be for related items.

When submitting product data, the Contractor shall modify drawings to delete any information not applicable to the project and add information that is applicable to the project. The Contractor shall mark copies of printed material to clearly identify the pertinent materials, products or models.

Samples submitted shall be of sufficient size and quantity to clearly illustrate functional characteristics of product or material and full range of colors available. Field samples and mock-ups, where required, shall be erected at the project site where directed by the Engineer.

The Contractor shall notify the Engineer, in writing at time of submission, of deviations in submittals from requirements of the contract documents.

The Contracting Agency shall not be responsible for delays in reviewing submittals not submitted in accordance with these specifications or the contract documents. Review time allotments for all documents shall be in conformance with the Standard Specifications and/or contract documents.

1-05.8(4) Engineer's Review of Submittals

The Engineer's review of drawings and data submitted by the Contractor will cover only general conformity with the Contract drawings and specifications. The Engineer's review of submittals shall not relieve the Contractor from responsibility for errors, omissions, deviations, or responsibility for compliance with the Contract documents.

Review of a separate item does not constitute review of an assembly in which the item functions.

When the submittal or resubmittal is marked "APPROVED", "APPROVED AS NOTED", "FOR RECORD ONLY", or "NO EXCEPTION TAKEN", no resubmittal is required. When the submittal is marked "REJECTED" OR "REVISE AND RESUBMIT" the Contractor shall comply with any comments on the return submittal.

1-05.8(5) Resubmittals

When a submittal is marked “REVISE AND RESUBMIT” or “REJECTED,” the Contractor shall make the corrections as noted and instructed by the Engineer and resubmit via Procore®. The Contractor shall not install material or equipment that has received a review status of “REVISE AND RESUBMIT” or REJECTED”.

When corrected copies are resubmitted, the Contractor shall in writing direct specific attention to all revisions and shall list separately any revision made other than those called for by the Engineer on previous submittals. Procore will assign the resubmittal number of the original submittal followed by a revision number (1, 2, etc.) to indicate the sequence of the resubmittal.

Each submittal shall have a unique number assigned to it (via Procore) and RAM documents shall be consistent with Procore numbering.

The Contractor shall revise returned submittals as required and resubmit until approval or similar is obtained. Any associated progress delay due to the Contractor’s need to revise and resubmit is the Contractor’s sole responsibility.

The Contractor shall verify that all exceptions previously noted by the Engineer have been accounted for.

1-05.8(6) Clarifications

Clarifications of the Contract intent shall be submitted via a Request for Information (RFI) using Procore® as described in Section 1-05.17 of the Special Provisions. The Contractor shall provide a clear and concise clarification question, specific project document reference such as plan detail number or specification number, proposed solution to the clarification question, and provide any supporting documentation necessary to understand the clarification question.

1-05.11 Final Inspection

Delete this section and replace it with the following:

1-05.11 Final Inspections and Operational Testing
(October 1, 2005 APWA GSP)

1-05.11(1) Substantial Completion Date

When the Contractor considers the work to be substantially complete, the Contractor shall so notify the Engineer and request the Engineer establish the Substantial Completion Date. The Contractor’s request shall list the specific items of work that remain to be completed in order to reach physical completion. The Engineer will schedule an inspection of the work with the Contractor to determine the status of completion. The Engineer may also establish the Substantial Completion Date unilaterally.

If, after this inspection, the Engineer concurs with the Contractor that the work is substantially complete and ready for its intended use, the Engineer, by written notice to the Contractor, will set the Substantial Completion Date. If, after this inspection the Engineer does not consider the work substantially complete and ready for its intended use, the Engineer will, by written notice, so notify the Contractor giving the reasons therefor.

Upon receipt of written notice concurring in or denying substantial completion, whichever is applicable, the Contractor shall pursue vigorously, diligently and without unauthorized

interruption, the work necessary to reach Substantial and Physical Completion. The Contractor shall provide the Engineer with a revised schedule indicating when the Contractor expects to reach substantial and physical completion of the work.

The above process shall be repeated until the Engineer establishes the Substantial Completion Date and the Contractor considers the work physically complete and ready for final inspection.

1-05.11(2) Final Inspection and Physical Completion Date

When the Contractor considers the work physically complete and ready for final inspection, the Contractor by written notice, shall request the Engineer to schedule a final inspection. The Engineer will set a date for final inspection. The Engineer and the Contractor will then make a final inspection and the Engineer will notify the Contractor in writing of all particulars in which the final inspection reveals the work incomplete or unacceptable. The Contractor shall immediately take such corrective measures as are necessary to remedy the listed deficiencies. Corrective work shall be pursued vigorously, diligently, and without interruption until physical completion of the listed deficiencies. This process will continue until the Engineer is satisfied the listed deficiencies have been corrected.

If action to correct the listed deficiencies is not initiated within 7 days after receipt of the written notice listing the deficiencies, the Engineer may, upon written notice to the Contractor, take whatever steps are necessary to correct those deficiencies pursuant to Section 1-05.7.
The Contractor will not be allowed an extension of contract time because of a delay in the performance of the work attributable to the exercise of the Engineer's right hereunder.

Upon correction of all deficiencies, the Engineer will notify the Contractor and the Contracting Agency, in writing, of the date upon which the work was considered physically complete. That date shall constitute the Physical Completion Date of the contract, but shall not imply acceptance of the work or that all the obligations of the Contractor under the contract have been fulfilled.

1-05.11(3) Operational Testing

It is the intent of the Contracting Agency to have at the Physical Completion Date a complete and operable system. Therefore when the work involves the installation of machinery or other mechanical equipment; street lighting, electrical distribution or signal systems; irrigation systems; buildings; or other similar work it may be desirable for the Engineer to have the Contractor operate and test the work for a period of time after final inspection but prior to the physical completion date. Whenever items of work are listed in the Contract Provisions for operational testing they shall be fully tested under operating conditions for the time period specified to ensure their acceptability prior to the Physical Completion Date. During and following the test period, the Contractor shall correct any items of workmanship, materials, or equipment which prove faulty, or that are not in first class operating condition. Equipment, electrical controls, meters, or other devices and equipment to be tested during this period shall be tested under the observation of the Engineer, so that the Engineer may determine their suitability for the purpose for which they were installed. The Physical Completion Date cannot be established until testing and corrections have been completed to the satisfaction of the Engineer.

The costs for power, gas, labor, material, supplies, and everything else needed to successfully complete operational testing, shall be included in the unit contract prices related to the system being tested, unless specifically set forth otherwise in the proposal.

Operational and test periods, when required by the Engineer, shall not affect a manufacturer's guaranties or warranties furnished under the terms of the contract.

Add the following new section:

1-05.12(1) One-Year Guarantee Period
(March 8, 2013 APWA GSP)

The Contractor shall return to the project and repair or replace all defects in workmanship and material discovered within one year after Final Acceptance of the Work. The Contractor shall start work to remedy any such defects within 7 calendar days of receiving Contracting Agency's written notice of a defect, and shall complete such work within the time stated in the Contracting Agency's notice. In case of an emergency, where damage may result from delay or where loss of services may result, such corrections may be made by the Contracting Agency's own forces or another contractor, in which case the cost of corrections shall be paid by the Contractor. In the event the Contractor does not accomplish corrections within the time specified, the work will be otherwise accomplished and the cost of same shall be paid by the Contractor.

When corrections of defects are made, the Contractor shall then be responsible for correcting all defects in workmanship and materials in the corrected work for one year after acceptance of the corrections by Contracting Agency.

This guarantee is supplemental to and does not limit or affect the requirements that the Contractor's work comply with the requirements of the Contract or any other legal rights or remedies of the Contracting Agency.

I. 1-05.13 Superintendents, Labor, and Equipment of Contractor
(August 14, 2013 APWA GSP)

Delete the sixth and seventh paragraphs of this section.

II. 1-05.13 Superintendents, Labor and Equipment of Contractor

(******)
(CITY OF BELLINGHAM Special Provision)

Section 1-05.13 is supplemented with the following:

Upon request, the Contractor shall provide the City with a copy of the Contractor's signed Daily Activity Log by the end of the next working day. All force account billings shall include a copy of the contractor's daily activity log. Claims or protests based on daily activity without a timely submission of the daily activity log shall be denied.

1-05.15 Method of Serving Notices
(January 4, 2024 APWA GSP)

Revise the second paragraph to read:

All correspondence from the Contractor shall be served and directed to the Engineer. All correspondence from the Contractor constituting any notification, notice of protest, notice of dispute, or other correspondence constituting notification required to be furnished under the Contract, must be written in paper format, hand delivered or sent via certified mail delivery service with return receipt requested to the Engineer's office. Electronic copies such as e-mails or electronically delivered copies of correspondence will not constitute such notice and will not comply with the requirements of the Contract.

Add the following new section:

1-05.16 Water and Power

(October 1, 2005 APWA GSP)

The Contractor shall make necessary arrangements, and shall bear the costs for power and water necessary for the performance of the work, unless the contract includes power and water as a pay item.

Add the following new section:

1-05.18 Record Drawings

(March 8, 2013 APWA GSP)

The Contractor shall maintain one set of full size plans for Record Drawings, updated with clear and accurate red-lined field revisions on a daily basis, and within 2 business days after receipt of information that a change in Work has occurred. The Contractor shall not conceal any work until the required information is recorded.

This Record Drawing set shall be used for this purpose alone, shall be kept separate from other Plan sheets, and shall be clearly marked as Record Drawings. These Record Drawings shall be kept on site at the Contractor's field office, and shall be available for review by the Contracting Agency at all times. The Contractor shall bring the Record Drawings to each progress meeting for review.

The preparation and upkeep of the Record Drawings is to be the assigned responsibility of a single, experienced, and qualified individual. The quality of the Record Drawings, in terms of accuracy, clarity, and completeness, is to be adequate to allow the Contracting Agency to modify the computer-aided drafting (CAD) Contract Drawings to produce a complete set of Record Drawings for the Contracting Agency without further investigative effort by the Contracting Agency.

The Record Drawing markups shall document all changes in the Work, both concealed and visible. Items that must be shown on the markups include but are not limited to:

- Actual dimensions, arrangement, and materials used when different than shown in the Plans.
- Changes made by Change Order or Field Order.
- Changes made by the Contractor.
- Accurate locations of storm sewer, sanitary sewer, water mains and other water appurtenances, structures, conduits, light standards, vaults, width of roadways, sidewalks, landscaping areas, building footprints, channelization and pavement markings, etc. Include pipe invert elevations, top of castings (manholes, inlets, etc.).

If the Contract calls for the Contracting Agency to do all surveying and staking, the Contracting Agency will provide the elevations at the tolerances the Contracting Agency requires for the Record Drawings.

When the Contract calls for the Contractor to do the surveying/staking, the applicable tolerance limits include, but are not limited to the following:

	Vertical	Horizontal
As-built sanitary & storm invert and grate elevations	± 0.01 foot	± 0.01 foot
As-built monumentation	± 0.001 foot	± 0.001 foot

As-built waterlines, inverts, valves, hydrants	± 0.10 foot	± 0.10 foot
As-built ponds/swales/water features	± 0.10 foot	± 0.10 foot
As-built buildings (fin. Floor elev.)	± 0.01 foot	± 0.10 foot
As-built gas lines, power, TV, Tel, Com	± 0.10 foot	± 0.10 foot
As-built signs, signals, etc.	N/A	± 0.10 foot

Making Entries on the Record Drawings:

- Use erasable colored pencil (not ink) for all markings on the Record Drawings, conforming to the following color code:
- Additions - Red
- Deletions - Green
- Comments - Blue
- Dimensions - Graphite
- Provide the applicable reference for all entries, such as the change order number, the request for information (RFI) number, or the approved shop drawing number.
- Date all entries.
- Clearly identify all items in the entry with notes similar to those in the Contract Drawings (such as pipe symbols, centerline elevations, materials, pipe joint abbreviations, etc.).

The Contractor shall certify on the Record Drawings that said drawings are an accurate depiction of built conditions, and in conformance with the requirements detailed above. The Contractor shall submit final Record Drawings to the Contracting Agency. Contracting Agency acceptance of the Record Drawings is one of the requirements for achieving Physical Completion.

Payment will be made for the following bid item:

Record Documents (Minimum Bid ***$25,000***)	Lump Sum

Payment for this item will be made on a prorated monthly basis for work completed in accordance with this section up to 75% of the lump sum bid. The final 25% of the lump sum item will be paid upon submittal and approval of the completed Record Drawings set prepared in conformance with these Special Provisions.

A minimum bid amount has been entered in the Bid Proposal for this item. The Contractor must bid at least that amount.

1-06.6 Recycled Materials

(January 4, 2016 APWA GSP)

Delete this section, including its subsections, and replace it with the following:

The Contractor shall make their best effort to utilize recycled materials in the construction of the project. Approval of such material use shall be as detailed elsewhere in the Standard Specifications.

Prior to Physical Completion the Contractor shall report the quantity of recycled materials that were utilized in the construction of the project for each of the items listed in Section 9-03.21. The report shall include hot mix asphalt, recycled concrete aggregate, recycled glass, steel furnace slag and other recycled materials (e.g. utilization of on-site material and

aggregates from concrete returned to the supplier). The Contractor's report shall be provided on DOT form 350-075 Recycled Materials Reporting.

1-07 LEGAL RELATIONS AND REPONSIBILITIES TO THE PUBLIC

1-07.1 Laws to be Observed
(October 1, 2005 APWA GSP)

Supplement this section with the following:

In cases of conflict between different safety regulations, the more stringent regulation shall apply.

The Washington State Department of Labor and Industries shall be the sole and paramount administrative agency responsible for the administration of the provisions of the Washington Industrial Safety and Health Act of 1973 (WISHA).

The Contractor shall maintain at the project site office, or other well known place at the project site, all articles necessary for providing first aid to the injured. The Contractor shall establish, publish, and make known to all employees, procedures for ensuring immediate removal to a hospital, or doctor's care, persons, including employees, who may have been injured on the project site. Employees should not be permitted to work on the project site before the Contractor has established and made known procedures for removal of injured persons to a hospital or a doctor's care.

The Contractor shall have sole responsibility for the safety, efficiency, and adequacy of the Contractor's plant, appliances, and methods, and for any damage or injury resulting from their failure, or improper maintenance, use, or operation. The Contractor shall be solely and completely responsible for the conditions of the project site, including safety for all persons and property in the performance of the work. This requirement shall apply continuously, and not be limited to normal working hours. The required or implied duty of the Engineer to conduct construction review of the Contractor's performance does not, and shall not, be intended to include review and adequacy of the Contractor's safety measures in, on, or near the project site.

1-07.2 State Taxes

Delete this section, including its sub-sections, in its entirety and replace it with the following:

1-07.2 State Sales Tax
(June 27, 2011 APWA GSP)

The Washington State Department of Revenue has issued special rules on the State sales tax. Sections 1-07.2(1) through 1-07.2(3) are meant to clarify those rules. The Contractor should contact the Washington State Department of Revenue for answers to questions in this area. The Contracting Agency will not adjust its payment if the Contractor bases a bid on a misunderstood tax liability.

The Contractor shall include all Contractor-paid taxes in the unit bid prices or other contract amounts. In some cases, however, state retail sales tax will not be included. Section 1-07.2(2) describes this exception.

The Contracting Agency will pay the retained percentage (or release the Contract Bond if a FHWA-funded Project) only if the Contractor has obtained from the Washington State Department of Revenue a certificate showing that all contract-related taxes have been paid (RCW 60.28.051). The Contracting Agency may deduct from its payments to the Contractor

any amount the Contractor may owe the Washington State Department of Revenue, whether the amount owed relates to this contract or not. Any amount so deducted will be paid into the proper State fund.

1-07.2(1) State Sales Tax — Rule 171

WAC 458-20-171, and its related rules, apply to building, repairing, or improving streets, roads, etc., which are owned by a municipal corporation, or political subdivision of the state, or by the United States, and which are used primarily for foot or vehicular traffic. This includes storm or combined sewer systems within and included as a part of the street or road drainage system and power lines when such are part of the roadway lighting system. For work performed in such cases, the Contractor shall include Washington State Retail Sales Taxes in the various unit bid item prices, or other contract amounts, including those that the Contractor pays on the purchase of the materials, equipment, or supplies used or consumed in doing the work.

1-07.2(2) State Sales Tax — Rule 170

WAC 458-20-170, and its related rules, apply to the constructing and repairing of new or existing buildings, or other structures, upon real property. This includes, but is not limited to, the construction of streets, roads, highways, etc., owned by the state of Washington; water mains and their appurtenances; sanitary sewers and sewage disposal systems unless such sewers and disposal systems are within, and a part of, a street or road drainage system; telephone, telegraph, electrical power distribution lines, or other conduits or lines in or above streets or roads, unless such power lines become a part of a street or road lighting system; and installing or attaching of any article of tangible personal property in or to real property, whether or not such personal property becomes a part of the realty by virtue of installation.

For work performed in such cases, the Contractor shall collect from the Contracting Agency, retail sales tax on the full contract price. The Contracting Agency will automatically add this sales tax to each payment to the Contractor. For this reason, the Contractor shall not include the retail sales tax in the unit bid item prices, or in any other contract amount subject to Rule 170, with the following exception.

Exception: The Contracting Agency will not add in sales tax for a payment the Contractor or a subcontractor makes on the purchase or rental of tools, machinery, equipment, or consumable supplies not integrated into the project. Such sales taxes shall be included in the unit bid item prices or in any other contract amount.

1-07.2(3) Services

The Contractor shall not collect retail sales tax from the Contracting Agency on any contract wholly for professional or other services (as defined in Washington State Department of Revenue Rules 138 and 244).

1-07.6 Permits and Licenses (******)

(City of Bellingham Special Provision)

Section 1-07.6 is supplemented with the following:

The Contracting Agency has obtained the below-listed permit(s) for this project as indicated. A copy of the permit(s) is attached as an appendix for informational purposes. Copies of these permits, including a copy of the Transfer of Coverage form, when applicable, are required to be onsite at all times.

Contact with the permitting agencies, concerning the below-listed permit(s), shall be made through the Engineer with the exception of:

1. If applicable, when the Construction Stormwater General Permit coverage is transferred to the Contractor, direct communication with the Department of Ecology is allowed. The Contractor shall be responsible for obtaining Ecology's approval for any Work requiring additional approvals (e.g. Request for Chemical Treatment Form).
2. The Contractor shall be responsible for directly scheduling of all permit required inspections with the City of Bellingham Building Department (https://cob.org/services/permits/inspections).

The Contractor shall obtain additional permits as necessary. All costs to obtain and comply with the listed and any additional permits shall be included in the applicable Bid items for the Work involved.

NAME OF DOCUMENT	**PERMITTING AGENCY**	**PERMIT REFERENCE NO.**	**PROJECT MANUAL APPENDIX**
Building Permit	City of Bellingham Permit Center	BLD2025-0832	B.1 & B.5
Demolition Permit	City of Bellingham Permit Center	BLD2025-0833	B.2 & B.5
Mechanical Permit	City of Bellingham Permit Center	MEC2025-0796	B.3
Plumbing Permit	City of Bellingham Permit Center	PLM2025-0426	B.4
State Environmental Policy Act Determination of Non-Significance (SEPA DNS)	City of Bellingham Planning and Community Development Department	SEP2025-0021 & SHR2025-0015	B.6
Shoreline Permit Exemption Authorization	City of Bellingham Planning and Community Development Department	SHR2025-0015	B.7
Order of Approval to Construct (OAC)	Northwest Clean Air Agency	OAC 1437	B.8
Asbestos/Demolition Notification Approval and Permit to Work	Northwest Clean Air Agency	Notification 25-481	B.9
Electrical Permit	City of Bellingham Permit Center	**Contractor's Responsibility to obtain, including any fees for permitting or inspection**	**N/A**

Additionally, the following documents are relevant to this project. Select conditions/requirements are noted here for contractor convenience only; refer to the referenced document and Project Special Provisions for additional information.

NAME OF DOCUMENT	AGENCY / AUTHOR	CONDITIONS / REQUIREMENTS	PROJECT MANUAL APPENDIX
Geotechnical Design Services Report	Geoengineers, 12/19/2024	Subgrade soils information.	B.6 Exhibit B
Stormwater Engineering Report	Wilson Engineering, 10/7/2024	Stormwater design information	B.6 Exhibit C
Post Point Heron Colony Management Recommendations Update 2019	Nahkeeta Northwest Wildlife Services	Noise and disruption restrictions, seasonal and year-round.	B.6 Exhibit E
Asbestos Containing Material and Lead Based Paint Survey	All4 Inc, 3/5/2025 & 3/21/2025	Asbestos Containing Material not identified in samples collected. Lead Based Paint identified at some painted locations.	B.9 Exhibit A
Industrial Stormwater General Permit WAR005561	Issued: Washington Department of Ecology, Administered: City of Bellingham Department of Public Works	On-site Industrial Stormwater Training required for all contractor personnel.	B.10
Archaeological Resources Inadvertent Discovery Plan (IDP)	ESA, March 2025	Training on the IDP by the project Archaeologist is required for all crew members involved with ground disturbing work	C

Section 1-07.6 is further Supplemented with the following:
(CITY OF BELLINGHAM Special Provision)

Upon award of the Contract and prior to conducting any work the Contractor and any subcontractors must attend a training on the Industrial Stormwater General Permit. The training is one (1) hour, performed by the City and the Contractor must schedule the training with the City a minimum of 2-weeks in advance.

Before work begins, the successful bidder must have a valid City of Bellingham Business Registration Certificate and will be subject to paying Bellingham business and occupation taxes. For additional information, call the Finance Department, (360) 778-8000. Direct any bidding questions to the Purchasing Office (360) 778-7750 and any technical questions to the Project Engineer (360) 778-7900.

1-07.6 Permits and Licenses
(******)
(CITY OF BELLINGHAM Special Provision)

Add the following new sub-section:

1-07.6(1) Disposal of Surplus Excavated Material

All excavated material deemed by the Engineer to be surplus material shall be hauled to a waste site obtained by the Contractor, and disposed of in accordance with all applicable local, State and Federal requirements. If the quantity of surplus material hauled to any waste site exceeds 50 cubic yards, the Contractor shall obtain a Fill and Grading Permit from the Bellingham Planning and Economic Development Department or Whatcom County, whichever is appropriate. The Contractor is encouraged to reuse and recycle materials from the site whenever appropriate. A copy of the permit shall be submitted to the Engineer prior to the Contractor's use of the waste site. Failure by the Contractor to provide a Fill and Grading Permit, where appropriate, will result in deduction of material excavation and haul costs from the City's monthly payments to the Contractor.

1-07.6 Permits and Licenses

(******)
(CITY OF BELLINGHAM Special Provision)

Add the following new sub-section:

1-07.6(3) City Electrical Permit

Before beginning electrical installation the Contractor shall apply and pay for an electrical permit from the City's Permit Center. Prior to construction the Contractor shall schedule a meeting with the City Electrical Inspector to discuss work notification, the construction schedule, and any other items of work deemed appropriate.

1-07.9(3) Apprentices
(******)
(April 16, 2024, CITY OF BELLINGHAM Special Provision)

Apprentice Utilization Requirement

Standard Specification Section 1-07.9(3), Apprentices, is supplemented as follows:

Apprentice Utilization Requirement. No less than fifteen percent (15%) of the Labor Hours on the Project shall be performed by Apprentices for all Work included in the bid proposal.
Definitions. The following definitions apply throughout the Contract Documents unless the context clearly requires otherwise:

1. "Apprentice" means an apprentice enrolled in a State-approved Apprenticeship Training Program.

2. "Apprenticeship Utilization Plan" means a plan submitted by a prospective bidder specifically detailing verifiable efforts to meet the Apprenticeship Utilization Requirements

3. "Apprentice Utilization Requirement" means the requirement that the appropriate percentage of Labor Hours be performed by Apprentices.

4. “Good Faith Effort” (GFE) is used if the Contractor doesn’t meet the Apprentice Utilization Requirement. It describes the Contractor’s efforts to meet the Apprentice Utilization Requirement including but not necessarily limited to the specific steps as described elsewhere in this specification.

5. "Labor Hours" means the total hours of workers receiving an hourly wage who are directly employed upon the Project. "Labor Hours" includes hours performed by workers employed by the Contractor and all subcontractors working on the Project. "Labor Hours"

does not include hours worked by foremen, superintendents, owners, and workers who are not subject to prevailing wage requirements.

6. "State-approved Apprenticeship Training Program" means an apprenticeship training program approved by the Washington State Apprenticeship Council.

Apprentice Utilization Plan. The Contractor shall submit an Apprentice Utilization Plan by filling out the Apprentice Utilization Plan Form (WSDOT 424-005) within thirty (30) calendar days of Contract execution, demonstrating how and when it intends to achieve the Apprentice Utilization Requirement. The plan shall be in sufficient detail for the Engineer to track the Contractor's progress in meeting the Apprentice Utilization Requirement and be updated and resubmitted as the Work progresses or when ordered by the Engineer.

Contacts. The Contractor may obtain information on State-approved Apprenticeship Training Programs by contacting the Washington State Department of Labor and Industries at: Specialty Compliance and Services Division, Apprenticeship Section, P.O. Box 44530, Olympia, WA 98504-4530 or by phone at (360) 902-5320.

Payment. All costs incurred by the Contractor for complying with this Special Provision shall be included in the Contract prices for the Bid items of Work involved.

Apprentice Utilization Report. Contractor shall submit a preliminary Apprentice Utilization Report not later than thirty (30) days after substantial completion, and a final Apprentice Utilization Report not later than five (5) days after Physical Completion, certifying the following for the Project:

1. Name of each Apprentice and apprentice registration number;
2. Number of Apprentices and Labor Hours worked by them, categorized by trade or craft;
3. Number of journey level workers and Labor Hours worked by them, categorized by trade or craft;
4. Total Labor Hours; and
5. Percentage of total Labor Hours performed by Apprentices.

Compliance. In the event that the Contractor is unable to achieve the Apprentice Utilization Requirement, the Contractor shall submit to the City GFE documentation for review and approval. The GFE documentation shall be submitted not later than thirty (30) days after Substantial Completion. If GFE documentation was already submitted as part of the Apprentice Utilization Plan, it shall be updated and resubmitted not later than thirty (30) days after Substantial Completion. The GFE documentation may be further amended or supplemented not later than five (5) days after Physical Completion or such later date as the Engineer may approve in writing for good cause shown. If the Contractor fails to submit GFE documentation or if the Engineer does not approve the GFE, the Contractor will be subject to the Monetary Penalty set forth below.

Good Faith Efforts. The GFE documentation shall describe in detail why the Contractor is not or was not able to attain the Apprentice Utilization Requirement. The GFE documentation shall address one or more of the following areas:

1. Correspondence on solicitation of Apprentices from a State-approved Apprenticeship Training Program(s), and the response from the solicited State-approved Apprenticeship Training Program(s) when there is a lack of availability of Apprentices.

2. Provide documentation that shows contract requirements for Tribal Employment Rights Ordinance (TERO), Special Training, or Disadvantage Business Enterprise requirements affect the ability to obtain Apprentice Labor Hours on the Contract.

3. Provide documentation demonstrating what efforts the Contractor has taken to require subcontractors to solicit and employ Apprentices. Documentation could be posters placed on site, emphasis in subcontracts about employing Apprentices, letters, memos or other correspondence from Contractor to subcontractor that put an emphasis on employing Apprentices.

Monetary Incentive. A monetary incentive of one-tenth of one percent (0.1%) of the contract price, excluding sales or use tax, will be paid to the Contractor meeting the Apprentice Utilization Requirement.
Monetary Penalty. A monetary penalty will be applied to the Contractor failing to meet the Apprentice Utilization Requirement and failing to demonstrate a Good Faith Effort accepted by the Engineer. The penalty will be applied to every hour of shortfall of the minimum number of required Apprentice hours using the applicable published wage of a Step 1 apprentice laborer. The penalty shall not exceed one percent (1.0%) of the Contract price, excluding sales or use tax. The Engineer may deduct the penalty from any money due or coming due to the Contractor. No deduction or payment of the penalty will, in any degree, release the Contractor from further obligations or liabilities under the Contract.

1-07.9(5)A Required Documents
(February 17, 2026 APWA GSP, Option B)

Revise this section to read:

> All Statements of Intent to Pay Prevailing Wages and Affidavits of Wages Paid shall be submitted to the Engineer through the State L&I online Prevailing Wage Intent & Affidavit (PWIA) system. When apprenticeship is a requirement of the Contract, include all apprentices in PWIA.

1-07.11(2) Contractual Requirements
(November 25, 2024 APWA GSP)
Delete item 11 of the first paragraph of Section 1-07.11(2).

1-07.17 Utilities and Similar Facilities (******)
(CITY OF BELLINGHAM Special Provision)

The Contractor is cautioned that overhead and underground utilities exist in the construction area which may interfere with progress of work. The Contractor shall make every effort to locate the utilities ahead of the excavation and shall be responsible for their maintenance and protection during his operation. The Contractor is cautioned that the locations of existing utilities which are shown on the plans are approximate.

In the event that the owners of the utilities select to relocate them, the Contractor shall schedule and coordinate his work with that of the utilities owner so as to cause a minimum of mutual interference. Contractor shall notify the City within 48 hours per the procedures outlined in Section 1-04.5 of the Standard Specifications, if there is any delay by the utility owner that is causing the Contractor delay for which the Contractor may seek relief. Any delay or rescheduling of the Contractor's work caused by the relocation of utilities that is due to coordination or timing issues between the Contractor and utilities may be considered as incidental to construction for which additional compensation may not be allowed. The City will not pay for supporting utilities poles during construction. Support of poles shall be considered as incidental to construction and no additional compensation shall be allowed.

Any damages to existing utilities resulting from the Contractor’s operation shall be reported to the appropriate utility purveyor and to the Engineer. Such damage shall be repaired at the Contractor’s expense.

1-07.18 Public Liability and Property Damage Insurance

1-07.18(3) Initiating and Maintaining Coverage

(******)
(CITY OF BELLINGHAM Special Provision)

Section 1-07.18(3) is revised with the following:

Reference to the email address CAPS@WSDOT.WA.GOV is deleted and replaced with contracts@cob.org

Add the following new section:

1-08.0(1) Preconstruction Conference
(October 21, 2025 APWA GSP)

Prior to the Contractor beginning the work, a preconstruction conference will be held between the Contractor, the Engineer and such other interested parties as may be invited. The purpose of the preconstruction conference will be:

1. To review the initial progress schedule;
2. To establish a working understanding among the various parties associated or affected by the work;
3. To establish and review procedures for progress payment, notifications, approvals, submittals, etc.;
4. To review Training or Apprenticeship Plans, when applicable.
5. To discuss FSBE Goals when applicable.
6. To establish normal working hours for the work;
7. To review safety standards and traffic control; and
8. To discuss such other related items as may be pertinent to the work.

The Contractor shall prepare and submit at the preconstruction conference the following:

1. A breakdown of all lump sum items;
2. A preliminary schedule of working drawing submittals; and
3. A list of material sources for approval if applicable.

Add the following new section:

1-08.0(2) Hours of Work
(February 17, 2026 APWA GSP)

Except in the case of emergency or unless otherwise approved by the Engineer, the normal working hours for the Contract shall be any consecutive 8-hour period between ***7:00am***. and ***6:00pm***. ***Monday*** through ***Friday***, exclusive of a lunch break. If the Contractor desires different than the normal working hours stated above, the request must be submitted in writing prior to the preconstruction conference, subject to the provisions below. The working hours for the Contract shall be established at or prior to the preconstruction conference.

All working hours and days are also subject to local permit and ordinance conditions (such as noise ordinances).

If the Contractor wishes to deviate from the established working hours, the Contractor shall submit a written request to the Engineer for consideration. This request shall state what hours are being requested, and why. Requests shall be submitted for review no later than ***5 days*** prior to the day(s) the Contractor is requesting to change the hours.

If the Contracting Agency approves such a deviation, such approval may be subject to certain other conditions, which will be detailed in writing. For example:

1. On non-Federal aid projects, requiring the Contractor to reimburse the Contracting Agency for the costs in excess of straight-time costs for Contracting Agency representatives who worked during such times. (The Engineer may require designated representatives to be present during the Work. Representatives who may be deemed necessary by the Engineer include, but are not limited to: survey crews; personnel from the Contracting Agency's material testing lab; inspectors; and other Contracting Agency employees or third party consultants when, in the opinion of the Engineer, such Work necessitates their presence.)
2. Considering the Work performed on Saturdays, Sundays, and holidays as working days with regard to the contract time.
3. Considering multiple work shifts as multiple working days with respect to contract time even though the multiple shifts occur in a single 24-hour period.
4. If a 4-10 work schedule is requested and approved the non-working day for the week will be charged as a working day.

If Davis Bacon wage rates apply to this Contract, all requirements must be met and recorded properly on certified payroll.

1-08.1(7)A Payment Reporting
(November 25, 2024 APWA GSP
Delete this section and replace it with the following:

1-08.1(7)A VACANT

1-08.1(8)B Clauses Required in Subcontracts of All Tiers
(November 25, 2024 APWA GSP)
Delete item 8 of the second paragraph of Section 1-08.1(8)B.

1-08.1(9) Submittal of Executed Subcontracts

(April 22, 2025 APWA GSP, Option B)

Section 1-08.1(9) content and title are deleted and replaced with the following:

Vacant

1-08.3(2)A Type A Progress Schedule
(February 17, 2026 APWA GSP)

Revise this section to read:

The Contractor shall submit ***(3)*** copies of a Type A Progress Schedule no later than at the preconstruction conference, or some other mutually agreed upon submittal time. The schedule may be a critical path method (CPM) schedule, bar chart, or other standard schedule format. Regardless of which format is used, the schedule shall identify the critical path. The Engineer will evaluate the Type A Progress Schedule and accept or return the schedule for corrections within 15 calendar days of receiving the submittal.

1-08.5 Time for Completion

Section 1-08.5 is supplemented with the following:

(March 13, 1995 WSDOT GSP)

This project shall be physically completed within ***450*** working days.

1-08.5 Time for Completion
(February 17, 2026 APWA GSP, Option B)

Revise the third and fourth paragraphs to read:

Contract time shall begin on the first working day following the ***1st*** calendar day after the Notice to Proceed date. If the Contractor starts Work on the project at an earlier date, then contract time shall begin on the first working day when onsite work begins.

Each working day shall be charged to the Contract as it occurs, until the Contract Work is physically complete. If substantial completion has been granted and all the authorized working days have been used, charging of working days will cease. Each week the Engineer will provide the Contractor a statement that shows the number of working days: (1) charged to the Contract the week before; (2) specified for the physical completion of the Contract; and (3) remaining for the physical completion of the Contract. The statement will also show the nonworking days and all partial or whole days the Engineer declares as unworkable. The statement will be identified as a Written Determination by the Engineer. If the Contractor does not agree with the Written Determination of working days, the Contractor shall pursue the protest procedures in accordance with Section 1-04.5. By failing to follow the procedures of Section 1-04.5, the Contractor shall be deemed as having accepted the statement as correct. If the Contractor is approved to work 10 hours a day and 4 days a week (a 4-10 schedule) and the fifth day of the week in which a 4-10 shift is worked would ordinarily be charged as a working day, then the fifth day of that week will be charged as a working day whether or not the Contractor works on that day.

Revise the sixth paragraph to read:

The Engineer will give the Contractor written notice of the Completion Date of the Contract after all the Contractor's obligations under the Contract have been performed by the Contractor. The following events must occur before the Completion Date can be established:

1. The physical Work on the project must be complete; and
2. The Contractor must furnish all documentation required by the contract and required by law, to allow the Contracting Agency to process final acceptance of the contract. The following documents must be received by the Engineer prior to establishing a completion date:
   a. Certified Payrolls (per Section 1-07.9(5)).
   b. Material Acceptance Certification Documents
   c. Monthly Reports in DMCS of the amounts paid including the final payment confirmation to all firms required by Section 1-08.1(7)A if applicable
   d. Final Contract Voucher Certification
   e. Copies of the approved "Affidavit of Prevailing Wages Paid" for the Contractor and all subcontractors
   f. A copy of the Notice of Termination sent to the Washington State Department of Ecology (Ecology); the elapse of 30 calendar days from the date of receipt of the Notice of Termination by Ecology; and no rejection of the Notice of Termination by Ecology. This requirement will not apply if the Construction Stormwater General Permit is transferred back to the Contracting Agency in accordance with Section 8-01.3(16).
   g. Property owner releases per Section 1-07.24

1-08.9 Liquidated Damages
(February 17, 2026 APWA GSP, Option B)

Revise the second and third paragraphs to read:

Accordingly, the Contractor agrees:

1. To pay (according to the following formula) liquidated damages for each working day beyond the number of working days established for Physical Completion, and

2. To authorize the Engineer to deduct these liquidated damages from any money due or coming due to the Contractor.

Liquidated Damages Formula

LD=0.15C/T

Where:

LD = liquidated damages per working day (rounded to the nearest dollar)
C = original Contract amount
T = original time for Physical Completion

When the Contract Work has progressed to Substantial Completion as defined in the Contract, the Engineer may determine the Contract Work is Substantially Complete. The Engineer will notify the Contractor in writing of the Substantial Completion Date. For overruns in Contract time occurring after the date so established, the formula for liquidated damages shown above will not apply. For overruns in Contract time occurring after the Substantial Completion Date, liquidated damages shall be assessed on the basis of direct engineering and related costs assignable to the project until the actual Physical Completion Date of all the Contract Work. The Contractor shall complete the remaining Work as promptly as possible. Upon request by the Engineer, the Contractor shall furnish a written schedule for completing the physical Work on the Contract.

1-09.6 Force Account

(******)
(CITY OF BELLINGHAM Special Provision)

Supplement this section with the following:

Force Account shall be in accordance with Section 1-09.6 of the Standard Specifications except as follows:

Force account items shall be agreed upon in the field between the contractor and the inspector on a daily basis. Costs for force account work shall be submitted to the Engineer on a weekly basis.

Payment for small tools shall be considered incidental for payment of Contractor Crew Truck. In cases where no crew truck is used, payment for small tools shall be limited to 3-percent of amount paid for equipment. Equipment rates shall be limited to the maximum amount established by the FHWA Blue Book.

1-09.9 Payments
(******)

(CITY OF BELLINGHAM Special Provision)

Supplement this section with the following:

Schedule of Values

The breakdowns required of the cost of Lump Sum Items shall be combined into the Contractor's Schedule of Values Submittal.

Submit to the Engineer a balanced price segregation of the lump sum bid into items similar to the various subdivisions of the general and detailed specifications, the sum of which shall equal the lump sum bid.

1. The cost of various materials shall be furnished upon request of the Engineer, and such data will then be used as a basis for making progress estimates.
2. Breakdown costs, itemized by Specification Section and trade, and distribute cost to individual applicable units and structures.
3. Where structures, units, equipment or other components are identified by a specific series or, identification number, utilize said designation throughout cost breakdown.
4. Provide detailed breakdown for piping or conduit runs and identify approximate quantities involved to satisfaction of the Engineer.
5. Provide separate breakdown for change order items requested.

A reasonable allocation of the Contract Price to the component parts of the Work will be approved if component parts of the Work have values assigned to them that are well-balanced with respect to relative values for similar work established by published estimating guides.

1. Unless otherwise agreed to at the Preconstruction Conference, Means Estimator Guide or other similar nationally recognized estimating guide shall be used for resolving differences between Engineer's and Contractor's opinions of allocation of values.
2. Consent of Surety: If Contractor and Engineer cannot mutually agree on a Schedule of Values, Engineer will approve a Schedule of Values approved by the Surety providing the Performance Bond.
3. Contractor's costs shall not govern the allocation of values when application of Contractor's costs to a component part of the Work results in any other component part or combination of component parts being under-valued in relation to conventional estimating guides.

The Schedule of Values Submittal shall be approved prior to first Application for Payment.

Application for Payment

The Contractor shall develop and prepare Monthly Summary estimate sheets and cost breakdown sheets showing overall project and individual lump sum item progress as related to the approved Schedule of Values. Submit this information with the Contractor's pay request breakdown. This documentation shall be reviewed for consistency with the partial estimates prepared by the Engineer.

1-09.11(3) Time Limitation and Jurisdiction
(December 30, 2022 APWA GSP)

Revise this section to read*:*

For the convenience of the parties to the Contract it is mutually agreed by the parties that all claims or causes of action which the Contractor has against the Contracting Agency arising from the Contract shall be brought within 180 calendar days from the date of final acceptance (Section 1-05.12) of the Contract by the Contracting Agency; and it is further agreed that all such claims or causes of action shall be brought only in the Superior Court of

the county where the Contracting Agency headquarters is located, provided that where an action is asserted against a county, RCW 36.01.050 shall control venue and jurisdiction. The parties understand and agree that the Contractor's failure to bring suit within the time period provided, shall be a complete bar to all such claims or causes of action. It is further mutually agreed by the parties that when claims or causes of action which the Contractor asserts against the Contracting Agency arising from the Contract are filed with the Contracting Agency or initiated in court, the Contractor shall permit the Contracting Agency to have timely access to all records deemed necessary by the Contracting Agency to assist in evaluating the claims or action.

1-09.13(3)A Arbitration General
(January 19, 2022 APWA GSP)

Revise the third paragraph to read:

The Contracting Agency and the Contractor mutually agree to be bound by the decision of the arbitrator, and judgment upon the award rendered by the arbitrator may be entered in the Superior Court of the county in which the Contracting Agency's headquarters is located, provided that where claims subject to arbitration are asserted against a county, RCW 36.01.050 shall control venue and jurisdiction of the Superior Court. The decision of the arbitrator and the specific basis for the decision shall be in writing. The arbitrator shall use the Contract as a basis for decisions.

1-09.13(4) Venue for Litigation
(December 30, 2022 APWA GSP)

Revise this section to read:

Litigation shall be brought in the Superior Court of the county in which the Contracting Agency's headquarters is located, provided that where claims are asserted against a county, RCW 36.01.050 shall control venue and jurisdiction of the Superior Court. It is mutually agreed by the parties that when litigation occurs, the Contractor shall permit the Contracting Agency to have timely access to all records deemed necessary by the Contracting Agency to assist in evaluating the claims or action.

PROJECT SPECIAL PROVISIONS
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

CITY OF BELLINGHAM, WASHINGTON

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

CITY PROJECT NO. EU-194
BID NUMBER 3B-2026

CONTRACT AND TECHNICAL SPECIFICATIONS

BID DOCUMENTS

VOLUME 1 OF 2

JANUARY 2026

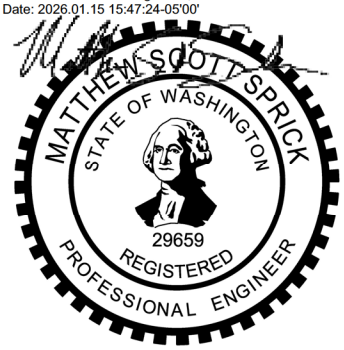
CITY OF BELLINGHAM, WASHINGTON

PRIMARY SLUDGE TANK REPLACEMENT

CONTRACT AND TECHNICAL SPECIFICATIONS

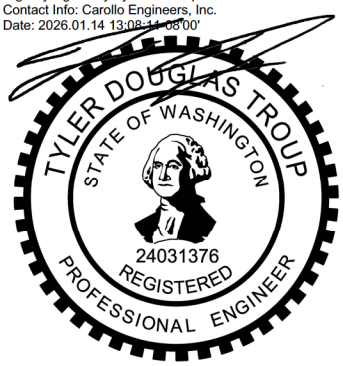
ENGINEER CERTIFICATION

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Date: 2026.01.15 15:47:24-05'00'



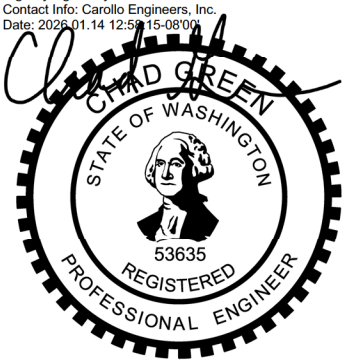
Matthew S. Sprick, Carollo Engineers
Divisions 01, 10, 40 (except 40_61_00, 40_61_15, 40_61_16.10, 40_64_01, 40_66_01, 40_67_01, 40_67_26, 40_71_15, 40_71_43, 40_71_79, 40_72_24, 40_72_76, 40_73_13, 40_73_23, 40_73_36, 40_73_63, 40_73_64, 40_75_59, 40_80_01, 40_96_15)
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Sections 09_96_01, 31_00_00, 31_05_15, 31_10_00, 31_23_19, 31_23_24, 31_23_35, 31_50_00, 33_05_61.02

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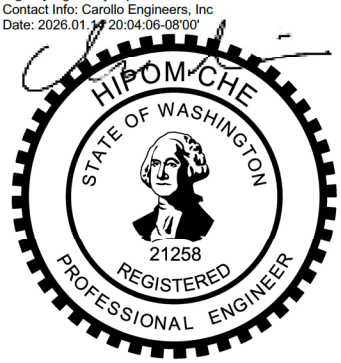
Tyler Troup, Carollo Engineers
Divisions 26, 28
Sections 40_61_00, 40_61_15, 40_61_16.10, 40_64_01, 40_66_01, 40_67_01, 40_67_26, 40_71_15, 40_71_43, 40_71_79, 40_72_24, 40_72_76, 40_73_13, 40_73_23, 40_73_36, 40_73_63, 40_73_64, 40_75_59, 40_80_01, 40_96_15

Digitally signed by Chad A. Green
Contact Info: Carollo Engineers, Inc.
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Chad Green, Carollo Engineers
Divisions 22, 23
Section 08_91_00

Digitally signed by Hipom Che
Contact Info: Carollo Engineers, Inc
Date: 2026.01.14 20:04:06-08'00'



Hipom Che, Carollo Engineers
Divisions 03, 05, 06, 07 (except 07_22_70, 07_54_23, 07_60_00)
Sections 08_11_13, 08_11_17, 08_71_00, 08_80_00, 09_22_17, 31_63_17, 31_63_14

CITY OF BELLINGHAM, WASHINGTON

PRIMARY SLUDGE TANK REPLACEMENT

CONTRACT AND TECHNICAL SPECIFICATIONS

ENGINEER CERTIFICATION



Tim Faber, King Architecture, LLC
Sections 07_22_00, 07_54_23, 07_60_00

KING
ARCHITECTURE

CITY OF BELLINGHAM, WASHINGTON

PRIMARY SLUDGE TANK REPLACEMENT

CONTRACT AND TECHNICAL SPECIFICATIONS

ENGINEER CERTIFICATION



1/14/2026

Paul Thomas, Wilson Engineering
Sections 31_25_14, 31_32_18.04, 32_01_15, 32_12_15, 32_16_13, 32_90_01, 33_41_00

WILSON ENGINEERING

CITY OF BELLINGHAM
PRIMARY SLUDGE TANK REPLACEMENT PROJECT

CITY PROJECT NO. EU-194
BID NUMBER 3B-2026

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40_05_31.14	POLYVINYL CHLORIDE (PVC) PIPE: PRESSURE
40_05_51.01	COMMON WORK RESULTS FOR VALVES
40_05_52	SPECIALTY VALVES
40_05_57.24	ELECTRIC ACTUATORS
40_05_62	PLUG VALVES
40_05_63	BALL VALVES
40_05_64	BUTTERFLY VALVES
40_05_65.01	GATE, GLOBE, AND ANGLE VALVES
40_05_65.24	CHECK VALVES

SECTION NO.	TITLE
40_05_67.40	AIR AND VACUUM RELIEF VALVES
40_41_00	PROCESS PIPING AND EQUIPMENT HEAT TRACING
40_61_00	COMMON WORK RESULTS FOR PROCESS CONTROL AND
40_61_15	CONTROL STRATEGIES
40_61_16.10	SPECIFIC CONTROL STRATEGIES
40_64_01	CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS
40_66_01	CONTROL SYSTEMS: NETWORK MATERIALS AND EQUIPMENT
40_67_01	CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS
40_67_26	CONTROL SYSTEMS: UNINTERRUPTIBLE POWER SUPPLIES 10 KVA AND BELOW
40_71_15	FLOW MEASUREMENT: MAGNETIC FLOWMETERS
40_71_43	FLOW MEASUREMENT: ROTAMETERS (VARIABLE AREA FLOWMETERS)
40_71_79	FLOW MEASUREMENT: SWITCHES
40_72_24	LEVEL MEASUREMENT: RADAR PULSE TIME OF FLIGHT (PTOF)
40_72_76	LEVEL MEASUREMENT: SWITCHES
40_73_13	PRESSURE/VACUUM MEASUREMENT: GAUGES
40_73_23	PRESSURE/VACUUM MEASUREMENT: DIRECT
40_73_36	PRESSURE/VACUUM MEASUREMENT: SWITCHES
40_73_63	PRESSURE/VACUUM MEASUREMENT: DIAPHRAGM AND ANNULAR SEALS
40_73_64	PRESSURE/VACUUM MEASUREMENT: INSTRUMENT VALVES
40_75_59	ANALYZERS: SLUDGE DENSITY METER
40_80_01	COMMISSIONING FOR INSTRUMENTATION AND CONTROLS
40_96_15	SCHEDULES: I/O LIST

DIVISION 41 - MATERIAL PROCESSING AND HANDLING EQUIPMENT

SECTION NO.	TITLE
41_22_24	MONORAIL SYSTEM

DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

SECTION NO.	TITLE
43_23_31.30	VERTICAL NON-CLOG CENTRIFUGAL PUMPS
43_23_31.31	RAS PUMP REPLACEMENT
43_23_58.13	SINGLE-LOBE ROTARY PUMPS
43_25_00.10	SUBMERSIBLE SUMP PUMPS

DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION NO.	TITLE
46_05_10	COMMON WORK RESULTS FOR MECHANICAL EQUIPMENT
46_05_94	MECHANICAL EQUIPMENT TESTING
46_34_01	INLINE DYNAMIC SLUDGE MIXER
46_41_10	SURFACE-MOUNTED MIXERS
46_78_83	PACKAGED BIOTRICKLING FILTER ODOR CONTROL SYSTEM

SECTION 01_11_00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Detailed description of the Work.

1.02 THE WORK

A. The Work consists of:
   1. Construction of Area 440 Sludge Storage Tanks and Odor Control System, and installation of new sludge pumps and sump pumps and associated equipment, instruments and piping in the existing Area 420 and 530. Structural modifications to existing building in Area 420 for new room separation and entrances. Demolition of existing Chlorine Building, demolition of portions of the structure, equipment and piping in Areas 420 and 530 to accommodate new equipment and structural features. Excavation, shoring, dewatering, and pile installation required for new construction in Area 440. Demolition and replacement of RAS pump discharge and header piping and two pumps, demolition and replacement of WAS pumps, installation of secondary clarifier dewatering pump and discharge piping, and temporary piping to accommodate the RAS work in Area 340. Work includes associated electrical equipment installation, heating, ventilation and air conditioning improvements, repair and reconstruction of existing structures affected by the Work, and incidentals for complete and usable facility.
   2. Commissioning of the Work.

1.03 LOCATION OF PROJECT

A. The Work is located at Post Point Wastewater Treatment Plant at 200 McKenzie Ave. Bellingham, WA 98225.

1.04 OWNER ASSIGNED SUBCONTRACTORS

A. Employ Owner-assigned Subcontractors for:
   1. None.

1.05 OWNER FURNISHED EQUIPMENT

A. Owner will furnish:
   1. None.

1.06 ACTIVITIES BY OTHERS

A. Activities by others which may affect performance of work include:
   1. McKenzie Street contaminated site cleanup project (EU198).
   2. PLC 3 Replacement.

1.07 PARTIAL USE OR OCCUPANCY

A. Substantial Completion on the following portions of Work for Owner's occupancy including specified testing, training of Owner's personnel, and other preparations necessary for Owner's occupancy or use:
   1. Area 530 Thickened Sludge Storage Pumps.
   2. Area 530 Sump Pumps.
   3. Area 530 Sludge/Polymer Mixer.

B. Following occupancy, Owner will:
   1. Provide power to operate equipment and systems.
   2. Repair damage caused by Owner's occupancy.

C. Following occupancy, Contractor will:
   1. Provide warranty services.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_11_02

CONTRACT DOCUMENT LANGUAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Explanation of arrangement, language, reference standards, and format.

1.02 REFERENCES

A. Construction Specifications Institute (CSI):
   1. MasterFormat™.
   2. SectionFormat™.
   3. PageFormat™.

1.03 PROJECT MANUAL ARRANGEMENT

A. Document and Section numbers used in Project Manual, and Project Manual arrangement are in accordance with CSI MasterFormat™, except where departures have been deemed necessary.

B. Sections are written in CSI SectionFormat™, Three-Part Section Format, except where departures have been deemed necessary.

C. Page format for Sections in the Project Manual is in PageFormat™, except where departures have been deemed necessary.

1.04 CONTRACT DOCUMENT LANGUAGE

A. Specification Section Paragraphs entitled "Section Includes" summarize briefly what is generally included in the section.
   1. Requirements of Contract Documents are not limited by "Section Includes" paragraphs.

B. Specifications have been partially streamlined by intentionally omitting words and phrases, such as "the Contractor shall," "in conformity therewith," "shall be" following "as indicated," "a," "an," "the" and "all."
   1. Assume missing portions by inference.

C. Phrase "by Engineer" modifies words such as "accepted," "directed," "selected," "inspected," and "permitted," when they are unmodified.

D. Phrase "to Engineer" modifies words such as "submit," "report," and "satisfactory," when they are unmodified.

E. Colons (:) are used to introduce a list of particulars, an appositive, an amplification, or an illustrative quotation:
   1. When used as an appositive after designation of product, colons are used in place of words "shall be."

F. Word "provide" means to manufacture, fabricate, deliver, furnish, install, complete, assemble, erect in place, test, or render ready for use or operation, including necessary related material, labor, appurtenances, services, and incidentals.

G. Words "Contractor shall" are implied when direction is stated in imperative mood.

H. Term "products" includes materials and equipment as specified in Section 01_60_00 - Product Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_14_00

WORK RESTRICTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for sequencing and scheduling the Work affected by existing site and facility, work restrictions, and coordination between construction operations and plant operations.

1.02 SUBMITTALS

A. Baseline Schedule with MOP tasks.

B. Method of Procedure (MOP) Form.

C. Method of Procedure (MOP) Log.

D. Progress Schedule with MOP tasks.

1.03 METHOD OF PROCEDURE (MOP)

A. Comply with MOP Instructions as specified in Attachment A - Method of Procedure (MOP).

B. Prepare MOP for the following conditions:
   1. Shutdowns, diversions, and tie-ins to the existing facility.
   2. Process start-up activities.
   3. Power interruption and tie-ins.
   4. Switch over between temporary and permanent facilities, equipment, piping, and electrical and instrumentation systems.
   5. Process constraints requiring interruption of operating processes or utilities.

C. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, Owner, or Engineer.

D. Submit Baseline Schedule, as specified in Section 01_32_21 - Schedules and Reports with proposed MOPs.

E. Submit MOP Log at construction progress meetings.

F. No consideration will be given to claims of additional time and cost associated to preparing MOPs required by the Owner and Engineer to complete this work in a manner that facilitates proper continuous operation of the facility and compliance with applicable regulations.

G. Where required to minimize treatment process interruptions while complying with specified constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.04 GENERAL CONSTRAINTS ON WORK AND SCHEDULING OF WORK

A. Perform abandoned pipe Work as specified in Section 01_35_21 -Selective Alterations and Demolition.

B. Wastewater projects:
   1. The Post Point Wastewater Treatment Plant is the City of Bellingham's only means of treating domestic and industrial wastewater prior to discharging to Puget Sound. Impairing the operational capabilities of this treatment plant will result in serious environmental damage and monetary fines to the Contractor.
   2. Conduct Work in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels sufficient to treat the quality of raw wastewater to the requirements of the applicable permits.
   3. Conduct commissioning activities as specified in Section 01_75_17 - Commissioning in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels sufficient to treat the quality of raw wastewater to the requirements of the applicable permits.
      a. Conduct PCIS Optimization and Fine-Tuning as specified in Section 01_75_17 - Commissioning.
   4. The status of the treatment plant shall be defined as "operational" when it is capable of treating the entire quantity of wastewater received to the requirements of the applicable permits.

1.05 COMPLIANCE WITH NORTHWEST CLEAN AIR AGENCY AIR PERMIT AND NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

A. National Pollutant Discharge Elimination System Permit:
   1. The existing facility is operating under the terms of a National Pollutant Discharge Elimination System permit issued by the Department of Ecology.
      a. This permit specifies the water quality limits that the plant must meet prior to discharge of effluent.
      b. A copy of the existing permit is on file for review at the Plant.
   2. Perform work in a manner that will not prevent the existing facility from achieving the finished water quality requirements established by regulations.
   3. Bear the cost of penalties imposed on the Owner for discharge violations caused by actions of the Contractor.

4. Conduct the Work and provide temporary facilities required to keep the existing plant continuously operational.
5. Do not remove or demolish existing facilities required to keep the existing plant operational at the capacities specified until the existing facilities are replaced by temporary, new, or upgraded facilities or equipment.
    a. Test replacement facilities to demonstrate operational success prior to removing or demolishing existing facilities.

B. Northwest Clean Air Agency Air Permit:
1. The existing facility is operating under the terms of an air permit issued by the Northwest Clean Air Agency.
    a. This permit specifies the air emissions limits that the plant must meet at their incineration, biofilter, activated sludge basins, secondary clarifiers, and secondary clarifier splitter box facilities.
    b. A copy of the existing permits are on file for review at the Plant.
2. Perform work in a manner that will not prevent the existing facility from achieving the emission limits established by regulations.
3. Bear the cost of penalties imposed on the Owner for discharge violations caused by actions of the Contractor.
4. Conduct the Work and provide temporary facilities required to keep the existing plant continuously operational.
5. Do not remove or demolish existing facilities required to keep the existing plant operational at the capacities specified until the existing facilities are replaced by temporary, new, or upgraded facilities or equipment.
    a. Test replacement facilities to demonstrate operational success prior to removing or demolishing existing facilities.

1.06 UTILITIES

A. Provide advance notice to and utilize services of Utility Notification Center (Call Before You Dig) for location and marking of underground utilities operated by utility agencies other than the Owner.

B. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.

C. New yard utilities were designed using existing facility drawings.
1. Field verification of utilities locations was not performed during design.
2. Services crossed or located nearby by new yard utilities may require relocation and possible shutdowns.
3. Pipe alignments as indicated on the Drawings.

1.07 WORK BY OTHERS

A. Where proper execution of the Work depends upon work by others, inspect and promptly report discrepancies and defects.

1.08 SHUTDOWN CONSTRAINTS

A. General shutdown constraints:
1. Execute the Work while the existing facility is in operation.

2. Some activities may be accomplished without a shutdown.
3. Apply to activities of construction regardless of process or work area.
4. Activities that disrupt plant or utilities operations must comply with these shutdown constraints.
5. Organize work to be completed in a minimum number of shutdowns.
6. Provide thorough advanced planning, including having required equipment, materials, and labor on hand at time of shutdown.
7. Shutdown MOPs:
    a. Advise the Engineer a minimum of 3 weeks prior to need for any complete or partial plant shutdown for tie-ins.
    b. Prepare and submit MOP to Engineer for any complete or partial plant shutdown required a minimum of 2 weeks prior to the shutdown.
    c. Owner's written approval of MOP is required prior to beginning Work.
8. Where required to minimize treatment process interruptions while complying with specified constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.
9. Final determination of the permitting of shutdowns will be the sole judgment of the Owner.
10. Owner maintains the ability to abort on the day of the scheduled shutdown.
11. Unplanned shutdowns due to emergencies are not specified in this Section.

B. Unit process availability work limitations:
    1. Shutdowns and tie-ins or other activities that disrupt plant operations are prohibited unless the following unit process availability conditions exist and unless otherwise approved in writing by the Owner and Engineer.
    2. At a minimum, the following facilities must be in service in order to proceed with a scheduled shutdown.
        a. Headworks including screening and grit removal and pumping.
        b. Primary treatment.
        c. Aeration basins.
        d. Secondary clarification.
        e. Disinfection.
        f. Existing solids thickening, dewatering, incineration and hauling.

C. Plant water system within each building area (but not the entire system).
    1. Maximum shutdown duration: 2 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

D. Raw sewage pump station (including pumping and piping).
    1. Maximum shutdown duration: Not allowed; bypass pumping required.

E. Sludge Storage system (including tank, pumping, and piping).
    1. Maximum shutdown duration: 4 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

F. Sludge Thickening system (including pumping, piping, and polymer systems).
    1. Maximum shutdown duration: 4 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

G. Sludge Dewatering (including pumping, piping, and polymer systems).
    1. Maximum shutdown duration: 4 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

H. WAS Pumping system (including pumping and piping).
    1. Maximum shutdown duration: 4 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

I. Shutdown of the waste activated sludge (WAS) pump station is allowed under the following conditions:
        a. Season: No restriction within shutdown period.
        b. Time of Day: No restriction within shutdown period.
        c. Duration: Maximum of 1 day per event.
        d. Limitations:
            1) A single WAS pump shutdown is allowed:
                a) Season: No restriction within shutdown period.
                b) Time of Day: No restriction within shutdown period.
                c) Duration: Maximum of 2 day per event.
            2) Simultaneous shutdown of the RAS pump station is not allowed.

J. RAS Pumping system (including pumping and piping).
    1. Maximum shutdown duration: 4 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

K. Primary Sludge Pumping system (including pumping and piping).
    1. Maximum shutdown duration: 4 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

L. Odor Control (including pumping and piping).
    1. Maximum shutdown duration: 4 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

M. Incineration (including pumping and piping).
    1. Maximum shutdown duration: 4 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

N. Instrument air system (including compressors and piping).
    1. Maximum shutdown duration: 2 hours.
    2. Schedule no more than 1 tie-in shutdown per day.

O. Electrical Shutdowns:
    1. Shutdown of switchgear SG-3401 may be allowed under the following conditions:
        a. Season: No restriction within shutdown period.
        b. Time of Day: No restriction within shutdown period.
        c. Duration: Maximum of 4 hours per event.

d. Limitations:
    1) Shutdown limitations match those described in this Section for the primary clarifiers, secondary clarifiers, RAS pumps, WAS pumps, W3 pumps, W4 pumps, and in-plant pumps.
    2) The “A” and “B” sides of SG-3401 may not be de-energized at the same time.
e. Equipment affected:
    1) SG-3401 provides power to the following equipment:
        a) MCC-3401 (Primary Clarifiers, Secondary Clarifiers W3 Pumps, W4 Pump).
        b) RAS Pumps.
        c) WAS Pumps.
        d) In-Plant Pumps.
        e) Raw Sewage Pumps.
        f) PP-34002 (gates and scum pipe operators).

2. Shutdown of motor control center MCC-3401 may be allowed under the following conditions:
    a. Season: No restriction within shutdown period.
    b. Time of Day: No restriction within shutdown period.
    c. Duration: Maximum of 4 hours per event.
    d. Limitations:
        1) Shutdown limitations match those described in this Section for the primary clarifiers, secondary clarifiers, W3 pumps and W4 pumps.
        2) The “A” and “B” sides of MCC-3401 may not be de-energized at the same time.
    e. Equipment affected:
        1) MCC-3401 provides power to the following equipment:
            a) Primary Clarifiers.
            b) Secondary Clarifiers.
            c) W3 Pumps.
            d) W4 Pump.
            e) Chlorine and Bisulfite Mixers.
            f) Secondary Sludge Pump Station HVAC.
3. Shutdown of PLC cabinet ACP-34000 may be allowed under the following conditions:
    a. Season: No restriction within shutdown period.
    b. Time of Day: No restriction within shutdown period.
    c. Duration: Maximum of 3 hours per event.
    d. Limitations:
        1) Shutdowns to connect new WAS Pump VFDs and new secondary clarifier dewatering pump starter and to disconnect existing equipment must be concurrent with shutdowns to SG-3401 or MCC-3401.
    e. Equipment affected:
        1) ACP-34000 provides automation to the primary and secondary clarifiers, all secondary sludge pump station equipment, and the W3 and W4 pumping systems. The plant will have to operate this equipment in manual during the shutdown.
4. Other Electrical and instrumentation - tie-in shutdowns:
    a. Maximum shutdown duration: 4 hours.
    b. Schedule no more than 1 tie-in shutdown per day.

P. Dewatering of existing process and disposal of residue:
    1. When the Owner has turned the process unit over to the Contractor for modification or temporary use, the Contractor is responsible for costs and procedures required to dewater and dispose of liquid, solids, etc. in the process unit:
        a. Drainage and disposal of process unit liquids, solids, etc. into another treatment process unit on the plant site may be allowed if approved in advance by the Engineer and Owner, and is conducted in accordance with Owner's requirements:
            1) The WAS pumping system shall be isolated and associated piping drained to perform tie-ins.
            2) The RAS pumping system shall be isolated and associated piping drained to perform tie-in.
        b. Costs for dewatering, disposal of solids and residuals, and preparation of surfaces for the Work are Contractor's responsibility:
            1) Includes tipping fees for the removal and disposal of the grit/debris. Dewatering of grit/debris to meet landfill requirements is the responsibility of the Contractor.

1.09 WORK RESTRICTIONS

A. Heron Colony work restrictions:
    1. The following restrictions apply to the indicated areas within the Heron Colony boundaries as indicated on the Contract Documents.
    2. 197 feet year round core zone protection buffer:
        a. Restricted Season: All year.
        b. Restrictions:
            1) All restrictions indicate on 300 ft and 656 ft buffer unless modified below.
            2) No disturbance to herons, heron colony, or associated habitat or vegetation.
            3) No disturbance to herons or bald eagles or their nests.
            4) No vegetation alteration, removal or tree cutting, or pruning within the forested area unless specifically allowed.
            5) No access into colony nucleus except for authorized personnel and heron monitoring biologist.
            6) No access into associated buffer area except for authorized personnel and heron monitoring biologist.
            7) No public access on public property except on designated public trail – pedestrian use only.
            8) No event activities, marathons, races or other potentially disturbing public trail use.
            9) No clearing, grading or development.
            10) No strobe, spot or high intensity lighting directed at colony.
            11) No drones.
    3. 300 ft season vegetation retention and no disturbance buffer:
        a. Restricted Season: January 15 to September 1
        b. Restriction:
            1) No disturbance to herons or bald eagles or their nests.
            2) No strobe, spot or high intensity lighting directed at colony.
            3) No application of pesticides without permit.

4) No drone use.
5) No large events or related activities on publics spaces or trails near colony.

4. 850 feet seasonal quiet buffer – extreme disturbance reduction zone:
   a. Restricted Season: January 15 to September 1.
   b. Restriction:
      1) No strobe, spot or high intensity lighting.
      2) Loud noises over 92 dB at colony boundary.

B. Return Activated Sludge (RAS) Flow:
   1. June 1 through September 30: 15 mgd.
      a. Pumps online required: 3 duty, 1 standby.
      b. RAS pump and piping replacement is not allowed.
   2. October 1 through May 31: 10 mgd.
      a. Pumps online required: 2 duty, 1 standby.
      b. Only one RAS pump may be offline during replacement.

C. Existing Sludge Storage Tank:
   1. Existing sludge storage tank cannot be demolished until the new sludge storage tank (Area 440), sludge storage building pumps (Area 420), and associated odor control system are commissioned.

D. Existing Thickened Sludge Pump Station (Area 530):
   1. At least one thickened sludge pump must remain in operation at all times.
   2. At least two thickened sludge pumps must remain in operation during the following window:
      a. August 15th to May 15th.
   3. Temporary piping may be required to accommodate replacement.

E. Existing Sludge/Polymer Mixer (Area 530):
   1. Must remain in service continuously. When replaced, arrange the construction schedule such that the new polymer/sludge mixer is installed and commissioned within 3 days of removing the existing mixer from service.

F. Yard piping, electrical duct banks, and trenches:
   1. Provide 1 open fire lane, designed for H-20 loadings, at all times during construction.

G. Provide safe, continuous access to process control equipment for plant operations and maintenance personnel.

H. Maintain truck access to the influent lift station, headworks bins, ash dumpsters, solids handling building (polymer/chemical delivery), hypochlorite generation facility (chemical delivery), and headworks bins.

I. Piping:
   1. Provide temporary piping during construction for existing and new equipment to maintain plant operation in service during construction.

1.10 WORK SEQUENCE

A. The following presents a general description of the major activities requiring sequencing or interface with the existing plant operation. It is not the intent of this section to list all sequences or schedules of work for this project. The Contractor shall prepare a detailed schedule for all sequenced work that must be reviewed by the Owner and Engineer before work can proceed. All temporary and permanent work performed to comply with sequencing requirements shall be a part of the bid. The work may proceed in the following sequence:
   1. Install erosion and sediment control facilities.
   2. Demolish existing Chlorine Building 420.
   3. Shore, excavate, and dewater the area previously occupied by Chlorine Building 420.
   4. Install auger cast piles.
   5. Construct Area 440 sludge storage tanks and associated yard piping.
   6. Restore Area 440 to rough final grade.
   7. Install Area 440 odor control system.
   8. Remove mechanical, electrical, and heating equipment inside Sludge Storage Building 420.
   9. Structural revisions to Sludge Storage Building 420, including a new double door, extending the grade-level floor across the building, seismic retrofits, and a new electrical room.
   10. Install new space heating system and crane system in Sludge Storage Building 420.
   11. Install new sludge storage pumps in the basement of Sludge Storage Building 420.
   12. Install new electrical equipment, lighting and control panel (RIO) in Sludge Storage Building 420.
   13. Provide new electrical supply to Sludge Storage Building 420 from the existing Hypochlorite Generation Facility 320.
   14. Install sludge storage tank odor control piping and remaining electrical/instrumentation.
   15. Add piping and valving to the existing pipe gallery and Solids Handling Building 530.
   16. Install MCC and PLC modifications to accommodate power and controls for new thickened sludge pumps and associated equipment/instruments.
   17. Replace the existing Thickened Sludge Pumps, one at a time, and associated piping with a new pump and piping, in the basement of Solids Handling Building 530. Commission the pump/system prior to replacing second pump.
   18. Install temporary polymer/sludge mixer and commission it.
   19. Replace existing polymer/sludge mixer with new, including associated sludge and polymer piping in the basement of Solids Handling Building 530.
   20. Field acceptable testing/commissioning of electrical, instrumentation and controls.
   21. Commission Area 440 odor control system.
   22. Commission Area 420 and Area 530 sump pumps.
   23. Commissioning of all new process equipment/systems together (with exclusion of previously commissioning Area 530 thickened sludge pumps, Area 440 odor control system, and area sump pumps).
   24. Demolition of the existing sludge storage tank in Solids Handling Building 510 and associated equipment.

B. RAS and WAS Modifications and associated electrical equipment:
   1. Install new WAS pumps, piping, and electrical conduit, wire, and equipment in the Gallery. Do not connect new piping to existing WAS piping. Pressure test piping with maximum extent of pipe installed as allowed.
   2. Install conduit for new WAS pump VFDs.
   3. Shutdown WAS pumps one at a time to replace the existing VFDs with new VFDs:
      a. Remove corresponding existing WAS VFD, WAS VFD transformer, and conduit to SG-3401. Protect existing conduit/wire to existing WAS pump for reconnection to new VFD.
      b. Core-drill new conduits for new WAS pump.
      c. Install new WAS VFD, connect to conduit from SG-3401, to conduit to new WAS pump, and to conduit/wire to existing WAS pump. Splice existing wire to new wire as required to connect to new WAS VFD.
      d. Return existing WAS pump to service, operating on the new VFD.
      e. Repeat steps 1) to 4) for the second WAS pump.
   4. Connect new WAS pumps to existing WAS/RAS piping, disconnect the existing conduit/wire to existing WAS pumps from the new WAS VFD, and connect new wire to new WAS pump VFDs for testing. Install temporary connections as necessary to permit reuse of existing WAS pumping system if required.
   5. Upon acceptance of testing, make final permanent piping connections and operate new WAS pumping system.
   6. Install new Secondary Clarifier Dewatering Pump, piping, electrical equipment, conduit and accessories. Do not connect new PD piping to new 30-inch RAS header piping. Pressure test piping with maximum extent of pipe installed as allowed.
   7. Install temporary RAS piping from the RAS pumps in the Secondary Sludge Pump Station to the 30-inch aboveground piping at the Selector/Activated Sludge Basin 1. Connect temporary piping to three of four existing RAS pumps and at the 30-inch elbow at the Selector/Activated Sludge Basin 1.
   8. The City will operate the RAS pumping system with these three pumps. See Section 01_50_00 - Temporary Facilities and Controls for description and requirements of the temporary RAS piping system.
   9. Isolate and drain 30-inch RAS pipeline in Secondary Sludge Pump Station and Gallery.
   10. Replace RAS pump discharge piping and 30-inch RAS header and piping to be replaced. Replace one of four RAS pumps with a new pump. Make final PD piping connection for the Secondary Clarifier Dewatering Pump to the new 30-inch RAS header piping.
   11. Test Secondary Clarifier Dewatering Pump and new RAS pump.
   12. Upon acceptance of testing, the City will startup RAS flow with the connected RAS pumps. Contractor shall remove temporary RAS piping and reconnect the RAS pumps to the new RAS piping.
   13. Replace the second RAS pump with a new pump once the other three are operational through the new RAS piping.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - METHOD OF PROCEDURE (MOP)

"METHOD OF PROCEDURE" (MOP)
Instructions and Forms

Definition and Purpose

"Method of Procedure" (MOP) is a detailed document submitted by the Contractor to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the Owner and Engineer that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The Owner should use the information within the MOP to define operational procedures and methods to safely and successfully assist the Contractor.

MOP Process Summary

WHO	STEP	TIMING
Contractor	1. Identify MOPs needed on MOP Log and Baseline Schedule.	No later than 7 days prior to Preconstruction Scheduling Meeting
Contractor, Owner, Engineer	2. Pre-MOP Meeting.	More than 28 days prior to work
Contractor	3. Submits MOP.	No later than 28 days prior to work
Owner	4. Reviews MOP.	
Owner	5. MOP finalized.	No later than 7 days prior to work
Contractor	6. Complete Readiness Checklist.	No later than 5 days prior to work
Contractor	7. Complete Safety Checklist.	Immediately prior to commencing work
Contractor	8. Complete Work.	
Contractor	9. Update MOP Log and Progress Schedules.	Monthly

MOP Process Detail

<u>STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.</u>

Contractor submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

STEP 2. Pre-MOP Meeting.

Contractor requests a Pre-MOP Meeting with the Owner and Engineer to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the Owner or Engineer if the work is deemed to be minor.

STEP 3. Submits MOP.

Contractor completes the MOP Form and submits 3 copies for approval to the Owner's Project Manager (OPM).

STEP 4. Reviews MOP.

OPM distributes MOP Form for review by the Owner's Construction Coordinator, O&M Representative, and Engineer's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in Contract Documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

STEP 5. MOP finalized.

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the Owner, Engineer, and Contractor.

STEP 6. Complete Readiness Checklist.

Contractor verifies everything is ready for the Work.

STEP 7. Complete Safety Checklist.

Contractor ensures safety.

STEP 8. Complete Work.

Contractor completes Work.

STEP 9. Update MOP Log and Progress Schedules.

Contractor updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.

ATTACHMENT B - METHOD OF PROCEDURE (MOP) FORM

METHOD OF PROCEDURE (MOP) FORM

Owner: _____ **Date:** _____

Contractor: _____ **Carollo Project No.:** _____

Project Name: _____ **Submittal No.:** _____

Submittal Title: _____ **Spec/Drawing. Ref.:** _____

MOP #:	TASK TITLE: *(Provide <10 word title)*	SUBMITTAL DATE: *(No later than 28 days prior to work)*

SCHEDULE OF WORK ACTIVITY:

START: *(Date/Time)* END: *(Date/Time)*

REQUESTOR:

PRIMARY POINT OF CONTACT:	PHONE/PAGER:
SECONDARY POINT OF CONTACT:	PHONE/PAGER:

NOTIFY:	☐	Control Room, Phone:	☐	Security, Phone:

BUILDING:	LOCATION OF WORK FLOOR/LEVEL:

DESCRIPTION OF WORK: *(Provide sufficient details on process isolation, work sequencing, and safety (i.e. control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)*

Task Summary: _____

Processes Affected: _____

Trades Affected: _____

WORK PLAN:

Work Sequencing: _____

Process Isolation: _____

Spill Prevention Plan: _____

Contingency Plans: _____

CRITICAL EQUIPMENT / TOOLS: *(Pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)*

☐	Acoustic Ceiling/or Walls Access	☐	Excavation Permit	☐	Lock Out/Tag Out
☐	Chemical Use Approval	☐	Fire Sprinkler Impairment	☐	Life Safety Systems
☐	Confined Space Permit	☐	Flammable Materials	☐	Roof Protocol
☐	Critical Lift Plan	☐	Flush / Discharge	☐	Work After Dark
☐	Energized Electrical Work	☐	High Pressure Test	☐	
☐	Elect. Panel Schedules	☐	Hot Work/Open Flame	☐	

EXISTING SERVICE(S) AT RISK:							
☐	Breathing Air	☐	Elect Normal	☐	Process Access	☐	Telephones
☐	Chemical Distribution	☐	Fire Protection	☐	Safety Showers	☐	UPS
☐	City Water	☐	HVAC	☐	SCADA	☐	VAX/DATA
☐	Communication	☐	Inert Gas	☐	Security	☐	
☐	Domestic Drain	☐	Instrument - Air	☐	Solvent Drain	☐	
☐	Elect-Bus Duct	☐	Life Safety System	☐	Specialty Gases	☐	
☐	Elect. Emergency	☐	Natural Gas	☐	Storm Drain	☐	
REVIEWER'S INSTRUCTIONS/COMMENTS:							
☐	PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:						

	Full Name (printed)	**Signature**	**Phone**	**Date**
Submitted By				
System Owner				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				

ATTACHMENT C - READINESS CHECKLIST

READINESS CHECKLIST

(5 days prior to work)

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: _____

2. Review work plan: _____

3. Review contingency plan: _____

ATTACHMENT C - SAFETY CHECKLIST

SAFETY CHECKLIST

(Just prior to commencing work)

Checklist provided as a guide but is not all inclusive.

1. Location awareness:
   a. Emergency exits: _____
   b. Emergency shower and eyewash: _____
   c. Telephones and phone numbers: _____
   d. Shut-off valve: _____
   e. Electrical disconnects: _____
2. Inspect work area:
   a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. SDS (Safety Data Sheets):
   a. Understand the chemicals and substances in the area you are working in by reading the SDS.
4. Lockout/Tagout Procedure:
   a. Lockout/tagout energy sources before beginning work.
   b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
   c. Make sure the lines are depressurized.
5. Overhead work:
   a. Use appropriate personal protective equipment; i.e., safety harness, lifeline, etc.
   b. Select appropriate tie-off points; i.e., structurally adequate, not a pipe or conduit, etc.
   c. Spotter assigned and in position.
   d. Pipe rack access; i.e., check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
   a. Shepherd's hook.
   b. ARC flash protection.
   c. Fire extinguisher.
   d. Other: _____
7. Accidents:
   a. Should accidents occur, do not shut off and do not attempt to correct the situation unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review process start-up documents:
   a. In the event the system is shutdown, the Control Center should have a working knowledge of the process start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
   a. Do not obstruct evacuation routes.
   b. Take time to survey the area for evacuation routes.

ATTACHMENT D - METHOD OF PROCEDURE (MOP) LOG

METHOD OF PROCEDURE (MOP) LOG
Sample

MOP Number	Task Title	Date Requested	Date Approved	Date Work Planned	Work Completed (Yes/No)
001					
002					
003					

SECTION 01_20_20

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Procedures for measurement and payment of Work under this Contract for lump sum items and unit prices.

1.02 LUMP SUM ITEMS

A. All lump sum items, listed below, shall include in proportion to their effort, Contractor's fee for overhead and profit for continuous, full-time management of the Contract as described in the Contract Documents, covering a period of time not less than from the Notice to Proceed through the entire length of the allowable Contract Times specified in the Contract Documents.

B. Item 1L: Mobilization and Demobilization:
   1. Measurement:
      a. Mobilization and demobilization to/from site for general contractor.
      b. Preparation of staging area.
      c. Restoration of staging area to existing conditions.
      d. Temporary facilities as described in Specification Section 01_50_00 but not inclusive of temporary piping and bypass pumping included in other line items.
      e. Measurement for payment will be Lump sum.
   2. Payment:
      a. Lump sum.

C. Item 2L: Chlorine Building Demolition Work:
   1. Measurement:
      a. Work included in Area 420 - Chlorine Building.
      b. Demolition and disposal of existing piping, conduits, supports, pumps, equipment supports, tanks, structures, and other miscellaneous demolition requirements as indicated on the Drawings.
      c. This line item does not include work in the Area 420 - Sludge Storage Building.
      d. Measurement for payment will be Lump sum.
   2. Payment:
      a. Lump sum.

D. Item 3L: Auger Cast Piles:
   1. Measurement:
      a. Includes work for mobilization and demobilization of auger cast pile installer.

b. Include all costs in connection with the Work for pile work on the number and lengths of piles indicated on the Drawings, including pile material, installation, reinforcing, concrete, and other related items for a complete installation.
c. Measurement for payment shall be lump sum

2. Payment:
a. Lump Sum

E. Item 4L: Temporary Excavation Support:
1. Measurement:
a. Sheeting, shoring, and bracing, or equivalent method for the protection of life and limb in trenches and open excavation, in accordance with Washington Occupational Safety and Health Administration.
b. Includes work for settlement monitoring and other appurtenant work and materials.
c. Requirements as specified in Section 31_50_00 - Excavation Support and Protection.
d. Measurement for payment will be Lump sum.

2. Payment:
a. Lump sum.

F. Item 5L: Dewatering:
1. Measurement:
a. Includes work for dewatering and other appurtenant work and materials.
b. Measurement for payment will be Lump sum.

2. Payment:
a. Per lump sum.

G. Item 6L: Site Civil Work:
1. Measurement:
a. Removal and disposal of existing yard piping and conduits as indicated on the Drawings.
b. Yard piping installation and demolition.
c. Corrosion control.
d. Dust control and storm water pollution prevention.
e. Demolition and disposal of asphaltic paving, curb, gutter, and sidewalk.
f. Regrading disturbed area and preparing site for landscaping work.
g. Installation of top soil, planting and establishment of landscaping as indicated in the Drawings and Specifications.
h. Constructing new manholes as indicated on the Drawings.
1) Also included is saw cutting and removal of existing pavement outside of the limits of trenching for the sewer mains, excavation outside the limits of the sewer mains, temporary excavation support, furnishing and installing cast-in-place concrete manhole base with smooth shaped channels, bedding, backfill, compaction, elevation adjustments, pipe stub outs, connections to existing sewer lines, joint seals, patch liner at joints and pipe penetrations, air testing of manholes, and temporary pavement or surfacing, restoration of existing improvements and installation of manhole frames and covers.

i. Includes work for asphalt concrete pavement and base as specified in Section 31_05_15 - Soils and Aggregate for Earthwork and Section 32_12_16 - Asphaltic Concrete Paving.
j. Includes work for pipe materials and installation; protection and support of utilities adjacent to the Work; excavation, soil hauling and disposal, geogrid, stabilization fabric, backfilling, compaction, fine grading, elevation adjustments; pipe testing; marking tape; and other appurtenant work and materials.
k. Includes work for completely restoring property affected by construction operations to its original or required condition, including fence replacement, preliminary grading, placement of topsoil, fine grading, grass sodding or seeding (if required) and final cleanup including removal of stormwater pollution prevention systems and removal of equipment or materials related to construction.
l. Includes work for hydrostatic testing, disinfection (water line only), and activation of pipeline, if applicable.
m. Duct Banks:
    1) Installation of a new duct bank as specified in Section 26_05_44 - Duct Banks.
    2) Routing to accommodate other utilities.
    3) Trenching.
    4) Installing reinforcing steel.
    5) Installing conduit rack/chair.
    6) Installing concrete.
    7) Structural fill in addition to that defined in the Contract Documents.
    8) Does not include wire or wire pulling.
n. Includes excavation, hand excavation, protection of existing utilities, removal, and disposal of spoils and materials.
o. Measurement for payment shall be lump sum.

2. Payment:
    a. Lump sum.

H. Item 7L: Area 050 Work:
1. Measurement:
    a. Work included in Area 050.
    b. Demolition and disposal of existing piping, conduits, supports, pumps, equipment supports, tanks, structures, and other miscellaneous demolition requirements as indicated on the Drawings.
    c. Installation, commissioning, and testing of new work as indicated on the Drawings.
    d. Includes work required for management of temporary facilities to perform work associated with WAS piping and pumps, including, but not limited to, temporary piping, protection of temporary piping, temporary power, temporary pumps, secondary containment, monitoring of bypass pumps, and notification to private residences for service interruptions.
    e. This line item does not include new electrical or instrumentation work.
    f. Measurement for payment will be Lump sum.
2. Payment:
    a. Lump sum.

I. Item 8L: Area 340 Work:
   1. Measurement:
      a. Work included in Area 340.
      b. Demolition and disposal of existing piping, conduits, supports, pumps, equipment supports, tanks, structures, and other miscellaneous demolition requirements as indicated on the Drawings.
      c. Includes work required for management of temporary facilities to perform work associated with RAS piping and pumps, including, but not limited to, temporary piping, protection of temporary piping, and installation of modifications to existing piping to accommodate temporary piping work.
      d. Includes work, if proposed, for temporary power, temporary pumps, secondary containment, and monitoring of bypass pumps.
      e. Installation, commissioning, and testing of new work as indicated on the Drawings.
      f. This line item does not include new electrical or instrumentation work.
      g. Measurement for payment will be Lump sum.
   2. Payment:
      a. Lump sum.

J. Item 9L: Area 420 Work:
   1. Measurement:
      a. Work included in Area 420 - Sludge Storage Building.
      b. Demolition and disposal of existing piping, conduits, supports, pumps, equipment supports, tanks, structures and other miscellaneous demolition requirements for installation of new work as indicated on the Drawings.
      c. Installation, commissioning, and testing of new work as indicated on the Drawings.
      d. This line item does not include work in the Area 420 - Chlorine Building.
      e. This includes equipment and supports associated equipment around perimeter of Area 420.
      f. This line item does not include new electrical or instrumentation work.
      g. Measurement for payment will be Lump sum.
   2. Payment:
      a. Lump sum.

K. Item 10L: Area 440 Work:
   1. Measurement:
      a. Work included in Area 440.
      b. Installation, commissioning, and testing of new work as indicated on the Drawings.
      c. Includes structural fill, structural mat, rebar, and equipment pads.
      d. Includes restoring site to grade.
      e. Includes high performance tank liner (coating).
      f. This line item does not include new electrical or instrumentation work.
      g. Measurement for payment will be Lump sum.
   2. Payment:
      a. Lump sum.

L. Item 11L: Area 510 Work:
   1. Measurement:
      a. Work included in Area 510.

b. Demolition and disposal of existing piping, conduits, supports, pumps, equipment supports, tanks, structures, and other miscellaneous demolition requirements for installation of new work as indicated on the Drawings.
c. Installation, commissioning, and testing of new work as indicated on the Drawings.
d. This line item does not include new electrical or instrumentation work.
e. Measurement for payment will be Lump sum.

2. Payment:
a. Lump sum.

M. Item 12L: Area 530 Work:
1. Measurement:
a. Work included in Area 530.
b. Demolition and disposal of existing piping, conduits, supports, pumps, equipment supports, tanks, structures, and other miscellaneous demolition requirements for installation of new work as indicated on the Drawings.
c. Installation, commissioning, and testing of new work as indicated on the Drawings.
d. Temporary relocation of existing sludge/polymer mixer or temporary installation of a sludge/polymer mixer to meet work restrictions for Area 530 modifications.
e. This line item does not include new electrical or instrumentation work.
f. Measurement for payment will be Lump sum.

2. Payment:
a. Lump sum.

N. Item 13L: Electrical, Instrumentation, and Controls:
1. Measurement:
a. Electrical and Instrumentation Work.
b. Demolition and disposal of existing instruments, wiring, switches and other miscellaneous demolition requirements as indicated on the Drawings.
c. Installation, commissioning, and testing of new electrical and instrumentation work as indicated on the Drawings.
d. Integration and programming as indicated in the Contract Documents.
e. Measurement for payment will be Lump sum.

2. Payment:
a. Lump sum.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_26_00

CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for executing a change in the Work.

1.02 PRELIMINARY REQUIREMENTS

A. Change Order Cost Basis Summary Form:
   1. Submit a sample to Engineer for review within 15 calendar days following Notice to Proceed.
      a. Items will be reviewed and their value, percentage, or calculation method mutually agreed to by the Contractor and Owner prior to executing a Change Order on the Project.
   2. Used by the Contractor for pricing each Change Order required for additions, deletions, or revisions in the Work.
   3. Include the following information:
      a. Agreed upon markups, percentages, and procedures for calculating all surcharges, etc. associated with the Cost of the Change Order Work.
      b. References for unit price information and special unit price information.
      c. Attachments with the following information:
         1) Certified labor rates breakdown.
         2) Equipment rates.
         3) Bond and insurance rates (PI&I).

1.03 REQUEST FOR INFORMATION OR INTERPRETATION (RFI)

A. Contractor may issue RFIs to request interpretation of the documents or to request for information that may be missing.

B. General Instructions:
   1. Number RFIs consecutively.
      a. Add a consecutive letter to the RFI number on modified submittals of the same RFI (i.e., RFI 4B).
   2. Provide RFI for 1 item.
      a. There may be exceptions when multiple items are so functionally related that expediency indicates review of the group of items as a whole.
      b. RFIs with multiple items will be rejected without review.
   3. Contractor sign and date RFIs indicating review and approval.
      a. Contractor’s signature indicates that they have satisfied RFI review responsibilities and constitutes Contractor's written approval of RFI.
      b. RFIs without Contractor's signature will be returned to the Contractor unreviewed. Subsequent submittal of this information will be counted as the first resubmittal.

C. Engineer will render a written clarification, interpretation, or decision on the issue submitted or initiate an amendment or supplement to the Contract within 21 calendar days.
    1. In the event the Contractor identifies an RFI as critical to the progress of the project, Engineer will make every effort to reduce the RFI response time.

1.04 PRELIMINARY PROCEDURES

A. Owner or Engineer may initiate changes by submitting a Request for Proposal (RFP) to Contractor including the following information:
    1. Detailed description of the Change, Products, and location of the change in the Project.
    2. Supplementary or revised drawings or specifications.
    3. Projected time span for making the change, and a specific statement if overtime work is authorized.
    4. A specific period of time during which the requested price will be considered valid.
    5. Such request is for information only, and is not an instruction to execute the changes, or to stop work in progress.

B. Contractor may initiate changes by submitting a Change Proposal to Engineer containing the following:
    1. Description of proposed changes.
    2. Reason for making changes.
    3. Specific period of time during which requested price will be considered valid.
    4. Effect on Total Contract Cost and/or Contract Time.
    5. Documentation supporting any change in Total Contract Cost and/or Contract Time, as appropriate.

1.05 WORK CHANGE DIRECTIVE AUTHORIZATION

A. In lieu of a Request for Proposal (RFP), Engineer may issue a Work Change Directive Authorization for Contractor to proceed with a change for subsequent inclusion in a Change Order.

B. Authorization will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change and will designate method of determining any change in the Contract Sum and/or the Contract Time, as appropriate.

C. Owner and Engineer will sign and date the Work Change Directive Authorization as authorization for the Contractor to proceed with the changes.

D. Contractor may sign and date the Work Change Directive Authorization to indicate agreement with the terms.

1.06 FIELD ORDERS

A. Owner or Engineer may order minor changes in the Work without changes in Contract Price or Contract Times.

1.07 DOCUMENTATION OF CHANGE PROPOSALS

A. Change proposal:
   1. Support with sufficient substantiating data to allow Engineer to evaluate the quotation.
      a. Lump sum.
      b. Unit prices: Use previously established unit prices.
      c. Time-and-material/force account basis:
         1) Name of the Owner's authorized agent who ordered the work, and date of the order.
         2) Work Change Directive Authorization number as applicable.
         3) Dates and times work was performed, and by whom.
         4) Time record, summary of hours worked, and hourly rates paid.
         5) Receipts and invoices for:
            a) Equipment used, listing dates and times of use.
            b) Products used, listing of quantities.
            c) Subcontracts.
   2. Provide additional data to support time and cost computations:
      a. Labor required.
      b. Equipment required.
      c. Products required:
         1) Recommended source of purchase and unit cost.
         2) Quantities required.
      d. Taxes, insurance, and bonds.
      e. Credit for work deleted from Contract, similarly documented.
      f. Overhead and profit.
      g. Justification for change to Contract Time.

1.08 PREPARATION OF CHANGE ORDERS AND FIELD ORDERS

A. Engineer will prepare each Change Order and Field Order.

B. Change Orders:
   1. Will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.
   2. Will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.
   3. Recommendation of Change Proposal is indicated by Engineer's signature.
   4. Upon signature and execution by Owner, the Change Proposal becomes a Change Order altering the Contract Time and Total Contract Cost, as indicated.
      a. Owner's Representative will transmit one signed copy each to Contractor and Engineer.
   5. Contractor may only request payment for changes in the Work against an approved Change Order.
   6. If either Engineer or Owner's Representative disapproves the Change Proposal, the reason for disapproval will be stated.
      a. A request for a revised proposal or cancellation of the proposal will be shown.

1.09 LUMP-SUM/FIXED PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
   1. Engineer's Proposal Request and Contractor's responsive Change Proposal as mutually agreed between Owner and Contractor.
      a. Per paragraph 1-04.4 in the Washington State Department of Transportation Standard Specifications, Engineer's Change Proposal pricing may be unilaterally set by the Engineer where an agreement is not met.
   2. Contractor's Change Proposal for a change, as recommended by Engineer.

B. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

C. Contractor will sign and date the Change Order to indicate agreement with the terms.

1.10 UNIT PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
   1. Engineer's definition of the scope of the required changes.
   2. Contractor's Change Proposal for a change, recommended by Engineer.
   3. Survey of completed work.

B. The amounts of the unit prices to be:
   1. Those stated in the Contract.
   2. Those mutually agreed upon between Owner and Contractor.

C. When quantities of each of the items affected by the Change Order can be determined prior to start of the work:
   1. Owner and Engineer will sign and date the Change Order as authorization for Contractor to proceed with the changes.
   2. Contractor will sign and date the Change Order to indicate agreement with the terms.

D. When quantities of the items cannot be determined prior to start of the work:
   1. Engineer or Owner will issue a Work Change Directive authorization directing Contractor to proceed with the change on the basis of unit prices, and will cite the applicable unit prices.
   2. At completion of the change, Engineer will determine the cost of such work based on the unit prices and quantities used.
   3. Contractor shall submit documentation to establish the number of units of each item and any claims for a change in Contract Time.

E. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

F. Contractor will sign and date the Change Order to indicate their agreement with the terms.

1.11 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/WORK CHANGE DIRECTIVE AUTHORIZATION

A. Engineer will issue a Work Change Directive for the Owner's signature authorizing Contractor to proceed with the changes.

B. At completion of the change, Contractor shall submit itemized accounting and supporting data as specified in this Section.

C. Engineer will determine the allowable cost of such work, as provided in the Contract Documents.

D. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

E. Contractor will sign and date the Change Order to indicate their agreement.

1.12 CORRELATION WITH CONTRACTOR'S SUBMITTALS

A. Periodically, but not less than monthly, revise Schedule of Values and Applications for Payment forms to record each Change Order as a separate item of Work, and to record the adjusted Contract Sum.

B. Periodically, but not less than monthly, revise the Construction Schedule to reflect each change in Contract Time. Revise subschedules to show changes for other items of work affected by the changes.

C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_29_73

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for preparation, format, and submittal of Schedule of Values.

1.02 PREPARATION

A. Schedule of Values shall be a listing of all cost loaded, on-site construction activities from the progress schedule, listed in numerical order, showing that the sum total of all cost-loaded activities equal the Contract value. Schedule of value should follow the format of the bid proposal, and provide breakdown of quantities for lump sum items.

B. When the schedule is changed or revised to include added or deleted work, the Schedule of Values shall also be revised such that the sum total of all cost-loaded activities continuously equal the current Contract value.
   1. Equate the aggregate of these costs to the Lump Sum Contract Price.

C. Prepare Schedule of Values identifying costs of Major Items of Work.

1.03 SUBMITTALS

A. Submit Schedule of Values for the Preliminary Schedule as specified in, Section 01_32_21 - Schedules and Reports.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_29_77

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for preparation and submittal of Applications for Payment.

1.02 FORMAT

A. Develop satisfactory spreadsheet-type form generated by downloading cost data from the Progress Schedule.
   1. Submit payment requests and attach spreadsheet with cost data related to Progress Schedule.

B. Fill in information required on form.

C. When Change Orders are executed, add Change Orders at end of listing of scheduled activities:
   1. Identify change order by number and description.
   2. Provide cost of change order in appropriate column.

D. After completing, submit Application for Payment.

E. Engineer will review application for accuracy. When accurate, Engineer will transmit application to Owner for processing of payment.

F. Execute application with signature of responsible officer of Contractor.

1.03 SUBSTANTIATING DATA

A. Provide Substantiating Data identifying:
   1. Project.
   2. Application number and date.
   3. Cost flow summary.
   4. Updated schedule of values.
   5. Progress schedule.
   6. Detailed list of enclosures.
   7. Stored products log.
   8. Equipment log.
   9. Submit “certified” payroll, if applicable.
   10. Record (as-built) documents.
   11. Photos and videos from current pay period.
   12. Applicable unconditional waiver and release on progress payment for previous payment made by Owner.

1.04 SUBMITTALS

A. Submit Application for Payment and Substantiating Data with cover letter.

1.05 PAYMENT REQUESTS

A. Prepare progress payment requests on a monthly basis. Base requests on the breakdowns of costs for each scheduled activity and the percentage of completion for each activity.

B. Indicate total dollar amount of work planned for every month of the project. Equate sum of monthly amounts to Lump Sum Contract Price.

C. Generate Progress Payment request forms by downloading cost data from the schedule information to a spreadsheet type format.

D. Identify each activity on the Progress Schedule that has a cost associated with it, the cost for each activity, the estimated percent complete for each activity, and the value of work completed for both the payment period and job to date.

E. Prepare summary of cost information for each Major Item of Work listed in the Schedule of Values. Identify the value of work completed for both the payment period and job to date.

F. Payment period:
   1. Monthly Application for Payment period shall begin on the 1st day of each month, and end on the last day of each month.
   2. Submit Application for Payment to Engineer no later than the 5th day of each month for work completed the previous month.
   3. Engineer will finalize and submit recommendation for Application for Payment to Owner by the 15th day of each month to allow time for processing and approval.

1.06 COST SUMMARIES

A. Prepare Summary of Cost Information for each Major Item of Work listed in the Schedule of Values. Identify the Value of Work Completed for both the payment period and job to date.

B. Cash flow summary: Prepare cash flow summary, indicating total dollar amount of work planned for each month of the project. Equate sum of monthly amounts to Lump Sum contract price.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_31_19

PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
      a. Qualifications of Meeting Participants.
      b. Basic Meeting Requirements.
      c. Pre-construction Conference.
      d. Pre-construction Safety Conference.
      e. Pre-submittal Conference.
      f. Web Based Construction Document Management Software Training.
      g. Progress Meetings.
      h. Schedule Update Meetings.
      i. Quality Control Meetings.
      j. Pre-Installation Meetings.
      k. Maintenance of Plant Operations (MOPO) Meetings.
      l. Commissioning Coordination Meetings.
      m. Instrumentation and Control Coordination Meetings.
      n. Close-out Meeting.
      o. Post Construction Meeting.

1.02 QUALIFICATIONS OF MEETING PARTICIPANTS

A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of entity each represents.

1.03 BASIC MEETING REQUIREMENTS

A. Attendees:
   1. Meeting leader shall require attendance of parties directly affecting, or affected by, Work being discussed at the meeting.

B. Location:
   1. In location convenient for most invitees.

C. Notification:
   1. Meeting leader shall notify attendees of meeting, including an agenda, a minimum of 7 days prior to meeting.

D. Agenda:
   1. Meeting leader shall prepare copies of the agenda for participants and distribute at the meeting.

2. Minimum requirements:
    a. Meeting purpose.
    b. Review minutes of previous meeting.
    c. Safety and security.
    d. Discuss issues.
    e. Action items.
    f. Next meeting.

E. Meeting minutes:
    1. Meeting leader shall prepare draft minutes and send to attendees for comment within 7 days.
    2. Meeting leader shall incorporate comments from attendees and submit final meeting minutes to attendees within 7 days of receipt of comments.

1.04 PRE-CONSTRUCTION CONFERENCE

A. Engineer leads the meeting.

B. Timing:
    1. Upon issuance of Notice to Proceed, or earlier when mutually agreeable.

C. Required attendees:
    1. Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to the agenda.

D. Agenda minimum requirements:
    1. Meeting purpose:
        a. To establish working understanding between parties and to discuss Construction Schedule, Shop Drawings and other Submittals, cost breakdown of major lump sum items, processing of Submittals and applications for payment, and other subjects pertinent to execution of the Work.
    2. Adequacy of distribution of Contract Documents.
    3. Distribution and discussion of list of major subcontractors and suppliers.
    4. Proposed progress schedules and critical construction sequencing.
    5. Major equipment deliveries and priorities.
    6. Project coordination.
    7. Designation of responsible personnel.
    8. Procedures and processing of:
        a. Field decisions.
        b. Proposal requests.
        c. Submittals - separate meeting.
        d. Change Orders.
        e. Request for Information/Interpretations.
        f. Applications for Payment.
        g. Record documents.
    9. Use of premises:
        a. Office, construction, and storage areas.
        b. Owner's requirements.
    10. Construction facilities, controls, and construction aids.

11. Temporary utilities.
12. Safety and first aid procedures.
13. Security procedures.
14. Housekeeping procedures.
15. Safety and security.
16. Review proposed photographer Submittal.
17. Action items.
18. Next meeting.

1.05 PRE-CONSTRUCTION SCHEDULING MEETING

A. Engineer leads the meeting.

B. Timing:
   1. Within 7 days of Notice to Proceed, or earlier when mutually agreeable.

C. Required attendees:
   1. Contractor's project manager, superintendent, scheduler, Owner, Engineer, and others necessary to the agenda.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. To establish the format and features of the Construction Schedule.
   2. Schedule preparation.
   3. Reporting requirements.
   4. Updates and revision procedures.
   5. Schedule delay analysis procedures.
   6. Schedule methodology.
   7. Planned sequence of operations.
   8. Cost and labor loading methodology.
   9. Proposed activity coding structure as specified in Section 01_32_21 - Schedules and Reports.
   10. Naming convention: Name schedule files with the year, month and day of the data date, revision identifier, and a description of the schedule.
      a. Example 1: 2021_07_30 rev 1 draft baseline schedule.xer.
      b. Example 2: 2021_09_30 rev 2 sep final update.xer.
   11. Action items.
   12. Next meeting.

1.06 PRE-SUBMITTAL CONFERENCE

A. Engineer leads the meeting.

B. Timing:
   1. Prior to producing any Submittals.

C. Required attendees:
   1. Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors, individual equipment manufacturers furnishing major pieces of equipment, and others involved in performance of the Work, and others necessary to the agenda.

D. Agenda minimum requirements:
    1. Meeting purpose:
        a. Review the entire Project, equipment, control philosophy, schedules, and Submittal requirements.
        b. Awareness of requirements by major subcontractors, major suppliers, and major equipment manufacturers.
        c. Format and procedures for Submittals.
        d. Review of the master Submittal schedule.
    2. Review equipment list.
    3. Review Submittal schedule.
    4. Format of Submittals.
    5. Procedures and processing of Submittals.
        a. Review turn-around time.
    6. Discuss specific electrical and instrumentation and controls Submittal requirements.
    7. Safety and security.
    8. Action items.
    9. Next meeting.

1.07 WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT SOFTWARE TRAINING

A. Contractor can submit a written request to the Engineer to waive the training based on staff having sufficient familiarity with the software and its complete usage. Engineer will lead the meeting.

B. Timing:
    1. Upon issuance of Notice to Proceed, or earlier when mutually agreeable,
    2. Duration minimum: 2 hours.

C. Required attendees:
    1. Mandatory attendance.
        a. Contractor’s project manager.
        b. Contractor’s field superintendent.
        c. Contractor’s project engineer.
    2. Other attendees:
        a. Owner, Engineer, Contractor’s quality control manager, Contractor’s project scheduler and any other persons involved with preparing and transmitting documents.

D. Agenda minimum requirements:
    1. Meeting purpose:
        a. Train construction team on the use of the web based document management system software.
    2. Safety.
    3. General Items.
    4. Contractor functions.
    5. Owner functions.
    6. Engineer functions.
    7. Action items.

1.08 PROGRESS MEETINGS

A. Engineer will lead the meeting.

B. Timing:
   1. Hold meetings throughout progress of the Work at maximum weekly intervals.

C. Required attendees:
   1. Owner, Engineer, Contractor, Contractor's project manager, superintendent, quality control manager, project scheduler, major subcontractors and suppliers as appropriate to the agenda topics for each meeting.
   2. Additional invitees:
      a. Owner utility companies when the Work affects their interests, and others necessary to the agenda.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Provide the status of the Work.
   2. Review minutes of previous meeting.
   3. Safety and security.
   4. Construction schedule summary.
   5. Review of 6 weeks schedule.
      a. Contractor shall provide printed hard copies for each attendee.
   6. Review of off-site fabrication and delivery schedules.
   7. Review of Submittals schedule and status of Submittals.
   8. Request for information (RFI's) status.
   9. MOP's/shutdown coordination.
   10. Change order management status.
   11. Maintenance of quality standards (QA/QC).
   12. Field observations, problems, and conflicts.
   13. Commissioning.
   14. Partnering recognition status (optional).
   15. General items.
   16. Action items.
   17. Next meeting.

1.09 SCHEDULE UPDATE MEETINGS

A. Contractor leads the meeting.

B. Timing:
   1. Hold meetings throughout progress of the Work at maximum monthly intervals.

C. Required attendees:
   1. Owner, Engineer, Contractor, Contractor's project manager, general superintendent, project scheduler, major subcontractors and suppliers as appropriate to the agenda topics for each meeting.
   2. Additional invitees:
      a. Owner utility companies when the Work affects their interests and others necessary to the agenda.

D. Agenda minimum requirements:
    1. Meeting purpose:
        a. Identify and troubleshoot scheduling issues in a collaborative environment.
        b. Provide further detail on Work status.
    2. Review minutes of previous meeting.
    3. Review Monthly Schedule, (Actual Progress and Variance).
        a. “Activities Started/Completed” this period.
        b. “Activities Started/Completed” “Variance” Baseline vs. current.
        c. “Added/Deleted Activities”.
        d. “Revised Activity Descriptions”.
        e. Any significant Proposed Logic Changes.
    4. Review milestone “Substantial Completion” Schedule:
        a. “Critical” Activities - “Critical Area, Float and Vital Statistics”.
    5. Review “Cumulative and Monthly Costs” graph.
    6. Review “Budgeted Cost” indicating the Current Project Budgeted Cost.
    7. Safety and security.
    8. Action items.
    9. Next meeting.

1.10 PRE-INSTALLATION MEETINGS

A. Contractor leads the meeting.

B. Timing:
    1. When specified in Technical Sections or requested by Engineer, before commencing Work of specific section.

C. Required attendees:
    1. Owner, Engineer, Contractor, Contractor’s project manager, general superintendent, project scheduler, major subcontractors including electrical instrumentation, and suppliers as appropriate to the agenda topics for each meeting.
    2. Additional invitees:
        a. Owner utility companies when the Work affects their interests and others necessary to the agenda.

D. Agenda minimum requirements:
    1. Meeting purpose:
        a. Review conditions of installation, preparation, and installation procedures.
        b. Review coordination with related work.
    2. Review minutes of previous meeting.
    3. Safety and security.
    4. Action items.
    5. Next meeting.

1.11 PRE-SHUTDOWN MEETINGS

A. Contractor leads the meeting.

B. Timing:
   1. Short-term and longer-term shutdowns and other tie-ins that require an Owner approved MOP require a pre-shutdown meeting at Project site at least 3 working days prior to commencing shutdown for tie-in or modification of specific plant systems.

C. Required attendees:
   1. Require attendance of parties directly affecting, or affected by shutdown, including Engineer, specific work crews, Owner's construction, operations, and maintenance staff.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Review conditions of installation, preparation, and installation procedures.
      b. Review coordination with related work.
   2. Review minutes of previous meeting.
   3. Review accepted Construction Method of Procedure (MOP), as specified in Attachment A of Section 01_14_00 - Work Restrictions, including conditions of shutdown, preparation, and installation procedures.
   4. Review timelines and sequences.
   5. Review responsibilities.
   6. Review dry run plan and schedule, as necessary.
   7. Review coordination with related work.
   8. Safety and security.
   9. Action items.
   10. Next meeting.

1.12 QUALITY CONTROL MEETINGS

A. Contractor leads the meeting.

B. Timing:
   1. Hold meetings throughout progress of the Work at maximum weekly intervals.

C. Required attendees:
   1. Engineer, Construction manager and staff, Contractor's quality control manager, and staff.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Update Contractor's efforts to comply with quality requirements in the Contract Documents.
   2. Review minutes of previous meeting.
   3. Review of Work progress and schedule.
   4. Review of out-of-compliance inspection or test results.
   5. Field observations, problems, and decisions.
   6. Review of offsite fabrication and delivery schedules.
   7. Planned progress during succeeding work period.
   8. Coordination of required inspections and tests.
   9. Review 6-week schedule report with upcoming inspections and special tests.
   10. Maintenance of quality and work standards.

11. Other business relating to Work.
12. Safety and security.
13. Action items.
14. Next meeting.

1.13 COMMISSIONING COORDINATION MEETINGS

A. Contractor leads the meeting.

B. Timing:
   1. Separate commissioning coordination meetings will be scheduled as required by the Engineer.

C. Required attendees:
   1. Require attendance of parties directly affecting, or affected by process start-up and testing, including Engineer, Commissioning Coordinator, specific work crews, Owner's operations, and maintenance staff.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Coordinate commissioning activities.
   2. Review minutes of previous meeting.
   3. Review Commissioning schedule.
   4. Review Owner Training schedule.
   5. Review test plans.
   6. Review accepted Construction Method of Procedure (MOP), as specified in Attachment A of Section 01_14_00 - Work Restrictions.
   7. Owner makes final decision for commissioning GO or NO GO.
   8. Safety and security.
   9. Action items.
   10. Next meeting.

1.14 INSTRUMENTATION AND CONTROL COORDINATION MEETINGS

A. Meetings and conferences as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.15 CLOSE-OUT MEETING

A. Engineer leads the meeting.

B. Timing:
   1. After punch list items are completed.

C. Required attendees:
   1. Owner, Engineer, Contractor, Contractor's project manager, and superintendent.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Coordinate close-out activities.

2. Review minutes of previous meeting.
3. Review punch list completion.
4. Transfer of record documents.
5. Finalize payment.
6. Safety and security.
7. Action items.
8. Next meeting.

1.16 POST CONSTRUCTION MEETING

A. Engineer leads the meeting.

B. Timing:
   1. About 11 months after date of Substantial Completion.

C. Location:
   1. Meet in Owner's office or other mutually agreed upon place.

D. Required attendees:
   1. Engineer, Contractor, appropriate manufacturers, and installers of major units of constructions, affected Subcontractors, and Owner's operations and maintenance staff.

E. Agenda minimum requirements:
   1. Meeting purpose:
      a. Review Project for compliance with the Contract Documents.
   2. Inspect the Work and draft list of items to be completed or corrected.
   3. Review service and maintenance contracts and take appropriate corrective action when necessary.
   4. Complete or correct defective work and may extend correction period.
   5. Safety and security.
   6. Action items.
   7. Next meeting.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_31_24

WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for web-based construction document management.

1.02 REQUIREMENTS

A. Owner, Engineer, and Contractor shall utilize the specified Procore, web-based construction management software, for submission of data and documents.
   1. Web-based construction management software is available at no cost to Contractor's personnel, subcontractor personnel, Suppliers, consultants, Owner, and Engineer.
   2. Joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of Contract Documentation.
   3. Web based construction management software shall be the primary means of project information submission and management.

1.03 USER ACCESS LIMITATIONS

A. Provide a list of Contractor's key web based construction management software personnel for the Engineer's acceptance.

B. Engineer reserves the right to perform a security check on potential users.
   1. Contractor will be allowed to add additional personnel and subcontractors to the web-based construction management software.
   2. Subcontractors and Suppliers will be given access to web-based construction management software by and through the Contractor.
   3. Contractor is responsible for adding and removing users from the system after the initial setup by the Engineer.

C. Engineer will grant initial access to the web-based construction management software by creating user profiles to accepted Contractor personnel.
   1. User profiles will define levels of access into the system; determine assigned function based authorizations and user privileges.

1.04 JOINT OWNERSHIP OF DATA

A. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the web-based construction management software system) by Engineer and Contractor will be jointly owned.

1.05 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING

A. Review comments made (or lack thereof) by Owner on Contractor submitted documentation shall not relieve Contractor from compliance with requirements of the Contract Documents.

B. Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents.

C. Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

1.06 COMPUTER REQUIREMENTS

A. Contractor shall use computer hardware and software that meets the requirements of the web-based construction management software system as recommended by the web-based construction management software to access and utilize the web-based construction management software.

B. As recommendations are modified by the web-based construction management software, Contractor will upgrade their system(s) to meet or exceed the recommendations.
   1. Upgrading of Contractor's computer systems will not be justification for a cost or time modification to the Contract.

C. Ensure that connectivity to the web-based construction management software system is accomplished through DSL, cable, T-1 or wireless communications systems.
   1. Minimum bandwidth requirements for using the system is 5 Mbps. It is recommended a faster connection be used when uploading pictures and files into the system.

D. Web-based construction management software supports the current version of Chrome (preferred), Mozilla's Firefox, Microsoft Edge, and Apple's Safari on a rolling basis.
   1. Each time a new version of one of these browsers is released, the web-based construction management software will begin supporting the update and stop supporting the fourth-oldest version.

1.07 CONTRACTOR RESPONSIBILITY

A. Responsible for the validity of their information placed in the web-based construction management software and for the abilities of their personnel.

B. Entry of information exchanged and transferred between the Contractor and its subcontractors and suppliers on the web-based construction management software shall be the responsibility of the Contractor.

C. Accepted users shall be knowledgeable in the use of computers, including Internet browsers, email programs, CAD drawing applications, and Adobe Portable Document Format (PDF) document distribution program.

D. Utilize the existing forms in the web-based construction management software to the maximum extent possible. If a form does not exist in the web-based construction management software, Contractor must include a form of their own or provided by the Engineer as an attachment to a Submittal.

E. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. Contractor is responsible for the training of their personnel in the use of the web-based construction management software (outside what is provided by the Owner) and the other programs indicated above as needed.

1.08 TRAINING

A. Owner has arranged and paid for web-based training on using web-based construction management software for the Contractor.

B. Contractor shall arrange and pay for the facilities and hardware/software required to facilitate Contractor's training.

PART 2 PRODUCTS

2.01 DESCRIPTION

A. Web-based construction management software provided by Procore.

PART 3 EXECUTION

3.01 WEB-BASED CONSTRUCTION MANAGEMENT SOFTWARE UTILIZATION

A. Web-based construction management software shall be utilized in connection with all document and information management required by these Contract Documents.

3.02 SUBMITTALS

A. Use the web-based construction management software feature for Master Submittals List.
   1. Select from the predefined submittals list.

B. Content: As specified in Section 01_33_00 - Submittal Procedures.

C. Format: As specified in Section 01_33_00 - Submittal Procedures.

D. Submit Portable Document Format (PDF) documents to the web-based construction management software submittal work flow process and forms.
   1. Consolidate electronic format submittals with multiple pages into a single file.

E. Hardcopy Submittals:
   1. Three (3) hard copies required for Operation and Maintenance Manuals only.

F. Samples:
   1. Enter Submittal data information into the web-based construction management software.
   2. Attach a copy of the submittal form(s) to the sample.

G. Record and Closeout Submittals:
   1. Operation and maintenance data as specified in Section 01_78_24 - Operation and Maintenance Manuals.
   2. Extra materials, spare parts, etc.

3.03 REQUESTS FOR INFORMATION/INTERPRETATION (RFI)

A. Use web-based construction management software for RFIs as specified in Section 01_26_00 - Contract Modification Procedures.

3.04 OFFICIAL CORRESPONDENCE

A. Use web-based construction management software for memos, notices, change proposals, or any official correspondence.

3.05 INSPECTION REQUESTS

A. Use web-based construction management software to request inspection for a portion of Work that is ready for inspection and prior to covering up the Work.

3.06 FINANCIAL SUBMITTALS

A. Use web-based construction management software for financial submittals as specified in Section 01_33_00 - Submittal Procedures.

3.07 OTHER

A. Use web-based construction management software for daily reports, meeting agendas and minutes, and other construction documents.

END OF SECTION

SECTION 01_32_21

SCHEDULES AND REPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Schedules and reports.

1.02 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Baseline schedule: A planned and approved timetable projection that illustrates the project execution strategy, key deliverables, planned activity dates and milestones.
   2. Critical path: The longest sequence of dependent tasks in a project.
   3. Near critical path: The longest path after the critical path.
   4. Weather day: The Contractor being prevented or inhibited from performing at least 4 hours of work on the critical path due to weather conditions.

1.03 SCHEDULING FORMAT

A. Utilize critical path method (CPM) format.

B. Provide a cost and labor loaded Schedule.

C. Engineer approval of the format is required.

1.04 SCHEDULING HARDWARE AND SOFTWARE

A. Scheduling software and hardware shall be located on-site.

B. Prepare computerized schedule utilizing the most current version of Oracle Primavera P6 or Asta Powerproject.

C. Contractor and Engineer must agree on the format.

1.05 SCHEDULE PREPARATION

A. Preparation and submittal of Progress Schedule represents Contractor’s intention to execute the Work within specified time and constraints.

B. All costs associated with Schedule requirements are included in the Contract Price.

C. During preparation of the preliminary Progress Schedule, the Engineer will facilitate Contractor’s efforts by answering questions regarding sequencing issues, scheduling constraints, interface points, and dependency relationships.

D. Prepare Schedule utilizing precedence diagramming method (PDM).

E. Prepare Schedule utilizing activity durations in terms of working days.
   1. Do not exceed a 15 working day duration on activities except concrete curing, submittal review, and equipment fabrication and deliveries.
   2. Where duration of continuous work exceeds 15 working days, subdivide activities by location, stationing, or other sub-element of the Work.
   3. Coordinate holidays to be observed with the Owner and incorporate them into the Schedule as non-working days.

F. Failure to include an activity required for execution of the Work does not excuse Contractor from completing the Work and portions thereof within specified times and at price specified in Contract.
   1. Contract requirements are not waived by failure of Contractor to include required Schedule constraints, sequences, or milestones in Schedule.
   2. Contract requirements are not waived by Owner's acceptance of the Schedule. In the event of conflict between accepted Schedule and Contract requirements, terms of Contract govern at all times, unless requirements are waived in writing by the Owner.

G. Reference Schedule to working days beginning with Notice to Proceed as Contract Time as Day "1".

H. Baseline Schedule and project completion:
   1. Should Contractor submit a Baseline Schedule showing project completion more than 20 working days prior to Contract completion date, Owner may issue Change Order, at no cost to Owner, revising time of performance of Work and Contract completion date to match Contractor's Schedule completion date.
   2. Adjust accordingly any Contract milestone dates.

I. Imposed dates and hidden logic are prohibited.

J. Interim milestone dates, operational constraints:
   1. In event there are interim milestone dates and/or operational constraints set forth in Contract, show them on Schedule.
   2. Do not use zero total float constraint or mandatory finish date on such Contract requirements.

K. Contract float is for the mutual benefit of both Owner and Contractor.
   1. Changes to the Project that can be accomplished within this available period of float may be made by Owner without extending the Contract Time by utilizing float.
   2. Time extensions will not be granted nor delay damages owed until Work extends beyond currently accepted Contract completion date.
   3. Likewise, Contractor may utilize float to offset delays other than delays caused by the Owner.
   4. Mutual use of float can continue until all available float shown by Schedule has been utilized by either Owner or Contractor, or both. At that time, extensions of the Contract Time will be granted by Owner for valid Owner-caused or third

party-caused delays which affect the planned completion date and which have been properly documented and demonstrated by Contractor.

5. Non-sequestering of float: Pursuant to float sharing requirements of Contract, Schedule submittals can be rejected for use of float suppression techniques such as preferential sequencing or logic, special lead or lag logic restraints, extended activity durations, or imposed dates.

L. Resource loading and leveling:
   1. Input labor data on each schedule activity.
   2. Manpower data consists of the man-hours estimated to perform each task, categorized by trade.
   3. Provide leveled manpower requirements.
      a. Availability of the resources drive activity duration.

M. Cost loading: All schedules:
   1. Only on-site construction activities.
   2. The sum total of all cost loaded activities equal to the current value of the Contract, including change orders, at all times.
   3. Owner acceptance of the Baseline Schedule creates the Schedule of Values required as specified in Section 01_29_73 - Schedule of Values.
   4. Provide updated Schedule of Values as the monthly Payment Application as specified in Section 01_29_77 - Applications for Payment.
   5. Payments will not be made until the updated Schedule of Values is accepted.

N. Schedule logic:
   1. Assembled to show order in which Contractor proposes to carry out Work, indicate restrictions of access, availability of Work areas, and availability and use of manpower, materials, and equipment.
   2. Form basis for assembly of schedule logic on the following criteria:
      a. Which activities must be completed before subsequent activities can be started?
      b. Which activities can be performed concurrently?
      c. Which activities must be started immediately following completed activities?
      d. What major facility, equipment, or manpower restrictions are required for sequencing these activities?

1.06 SCHEDULER

A. Designate, in writing within 5 calendar days after Notice of Award, the person responsible for preparation, maintenance, updating, and revision of all schedules.

B. Scheduler shall have the authority to update Schedule on behalf of the Contractor.

C. Qualifications:
   1. A minimum of 5 years verifiable experience in preparation of construction schedules for projects of similar value, size, and complexity.
   2. Knowledge of critical path method (CPM) scheduling utilizing the specified software.

1.07 SUBMITTAL REQUIREMENTS

A. Preliminary and Baseline Progress Schedule.

B. Preliminary and Baseline Schedule of Values.

C. Preliminary and Baseline Schedule of Submittals.

D. On a monthly basis, updated Schedules as specified.

E. Final Schedules update as specified.

F. Revised Schedules and time impact analyses as specified.

G. Submit Schedules in the media and number of copies as follows:
   1. PDF format and in other formats specified in this Section.
   2. 2 sets of CPM Schedule data electronic files in a native backed-up file format.

1.08 GANTT CHART

A. Produce a clear, legible, and accurate calendar based, time scaled, and graphical network diagram.
   1. Group activities related to the same physical areas of the Work. Produce the network diagram based upon the early start of all activities.

B. Include for each activity, the description, activity number, estimated duration in working days, total float, and all activity relationship lines.

C. Illustrate order and interdependence of activities and sequence in which Work is planned to be accomplished.
   1. Incorporate the basic concept of the precedence diagram network method to show how the start of 1 activity is dependent upon the start or completion of preceding activities and its completion restricts the start of following activities.

D. Provide Progress Schedule showing the critical path for the Project.

E. Provide report of Near Critical Path activities for the Project, when required by the Engineer.

F. Delineate the specified Contract Times and identify the planned completion of the Work as a milestone.
   1. Show the time period between the planned and Contract completion dates, if any, as an activity identified as Project float.

G. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion dates as milestones.

H. Include, in addition to construction activities:
   1. Submission dates and review periods for major equipment submittals, shoring submittals, and indicator pile program:
      a. Shoring reviews: Allow 4-week review period for each shoring submittal.
      b. Pile indicator program: Allow 4-week review period for analysis of program.
   2. Any activity by the Owner or the Engineer that may affect progress or required completion dates.
   3. Equipment and long-lead material deliveries over 8 weeks.
   4. Approvals required by regulatory agencies or other third parties.

I. Produce electronic network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.

J. Identify the execution of the following:
   1. Mobilization.
   2. All required Submittals and Submittal review times showing 30 calendar day duration for such activities and equal amount of time for resubmittal reviews.
   3. Equipment and materials procurement/fabrication/delivery.
   4. Excavation.
   5. Shoring design and submission of detailed shoring submittals. Identify submission as a milestone.
   6. Shoring review, shoring materials procurement, shoring installation, and shoring removal.
   7. Piles.
   8. Backfill and compaction.
   9. Dewatering.
   10. Grading, subbase, base, paving, and curb and gutters.
   11. Fencing and landscaping.
   12. Concrete, including installation of forms and reinforcement, placement of concrete, curing, stripping, finishing, and patching.
   13. Tests for leakage of concrete structures intended to hold water.
   14. Metal fastenings, framing, structures, and fabrications.
   15. Wood structures, finish carpentry, architectural woodwork, and plastic fabrications.
   16. Waterproofing and dampproofing, insulation, roofing and flashing, and sealants.
   17. Doors and windows, including hardware and glazing.
   18. Finishes including coating and painting, flooring, ceiling, and wall covering.
   19. Building specialties including furnishings, laboratory equipment, and toilet and bath accessories.
   20. Process equipment, including identification of ordering lead-time, factory testing, and installation.
   21. Pumps and drives, including identification of ordering lead time, factory testing, and installation.
   22. Conveying equipment including hoists and cranes, conveyor systems, and materials handling equipment, including identification of ordering lead-time and installation.
   23. Other mechanical equipment including fans and heating, ventilating, and air conditioning equipment.
   24. Trenching, pipe laying, and trench backfill and compaction.

25. Piping, fittings, and appurtenances, including identification of ordering and fabrication lead time, layout, installation and testing.
26. Valves, gates, and operators, including identification of order lead-time, installation, and testing.
27. Plumbing specialties.
28. Electric transmission, service, and distribution equipment, including identification of ordering lead-time, and factory testing.
29. Other electrical work including lighting, heating and cooling, and special systems, including identification of ordering lead-time.
30. Instrumentation and controls, including identification of ordering lead-time.
31. Preliminary testing of equipment, instrumentation, and controls.
32. Commissioning phase:
    a. Source Testing.
    b. Owner Training.
    c. Installation Verification.
    d. Functional Testing.
    e. Start-up Phase.
    f. Start-up Period.
33. Instrumentation and Controls Performance Testing.
34. Substantial completion.
35. Punch list work.
36. Demobilization.

1.09 PRELIMINARY SCHEDULE

A. Procedure:
    1. Submit proposed Preliminary Schedule within 14 calendar days after Notice to Proceed.
    2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule to review and make necessary adjustments.
    3. Submit revised Preliminary Schedule within 5 calendar days after meeting.
    4. Update Preliminary Schedule monthly until the Baseline Schedule is accepted.

B. Format:
    1. Simplified Gannt chart.

C. Activities:
    1. Define activities to be completed in the first 90 calendar days of Work.
    2. Actualize activities performed during the first 90 days into the first monthly Schedule update.

1.10 PRELIMINARY SCHEDULE OF VALUES

A. Preliminary Schedule of Values as specified in Section 01_29_73 - Schedule of Values.

B. Procedure:
    1. Submit proposed Preliminary Schedule of Values within 14 calendar days after Notice to Proceed.

2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule of Values to review and make necessary adjustments.
3. Submit revised Preliminary Schedule of Values within 5 calendar days after meeting.

1.11 WORK WITHIN THE FIRST 90 DAYS

A. Proceed with Work after Preliminary Schedule and Preliminary Schedule of Values have been accepted by Owner.

B. Submittal and acceptance of Preliminary Schedule and Preliminary Schedule of Values is condition precedent to making of progress payments as specified in Section 01_29_77 - Applications for Payment and payments for mobilization costs otherwise provided for in the Contract.

1.12 SCHEDULE OF SUBMITTALS

A. Schedule of Submittals shall include Submittals required in the Contract Documents but not limited to test plans, training plans, test procedures, operation and maintenance manuals, Shop Drawings, samples, record documents, and specifically required certificates, warranties, and service agreements.

B. Preliminary Schedule of Submittals:
   1. Due date: After Preliminary Schedule has been submitted and accepted by the Owner.
   2. Format:
      a. Include Submittals anticipated in the first 90 calendar days after award of Contract using early start dates.
      b. Indicate week and month anticipated for submittal to Engineer.
      c. Indicate “Priority” Submittals where review time can impact Contractor’s schedule.
         1) “Priority” indication will not alter review times specified in Section 01_33_00 - Submittal Procedures.
         2) Engineer will endeavor to provide early review of “Priority” Submittals where possible.
   3. Submittal of Preliminary Schedule of Submittals shall be a condition precedent to Owner making progress payments during the first 90 calendar days after award of Contract.

C. Final Schedule of Submittals:
   1. Due date: 30 days after Baseline Schedule has been submitted and accepted by Owner.
   2. Format:
      a. Include Submittals using early start dates.
      b. Include all Submittals, including those required in the Preliminary Schedule of Submittals.
      c. Indicate week and month anticipated for submittal to Engineer.

d. Indicate “Priority” submittals where review time can impact Contractor’s schedule.
    1) “Priority” indication will not alter review times specified in Section 01_33_00 - Submittal Procedures.
    2) Engineer will endeavor to provide early review of “Priority” Submittals where possible.

3. Submittal of final Schedule of Submittals shall be a condition precedent to Owner making progress payments after the first 90 calendar days after Notice to Proceed.

D. Provide updated Schedule of Submittals with updated schedules if Schedule revisions change listing and timing of Submittals.

1.13 BASELINE PROGRESS SCHEDULE AND BASELINE SCHEDULE OF VALUES

A. Due date: No more than 45 calendar days after Notice to Proceed.

B. Format:
1. Progress Schedule: Show sequence and interdependence of all activities required for complete performance of all Work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract.
2. Schedule of Values: As specified in Section 01_29_73 - Schedule of Values.

C. Acceptance of the Baseline Progress Schedule and Baseline Schedule of Values by the Owner is a condition precedent to making payments as specified in Section 01_29_77 - Applications for Payment after the first 90 calendar days after Notice to Proceed.

1.14 SUMMARY SCHEDULE

A. Due date: At weekly progress meetings and after each Schedule update or Schedule revision.

B. Format:
1. Consolidate groups of activities associated with Major Items of Work shown on Baseline Schedule.
2. Intended to give an overall indication of the Project Schedule without a large amount of detail.

1.15 COST FLOW SUMMARY

A. Due date: After Baseline Schedule has been submitted and accepted by the Owner, submit on a monthly basis as specified in Section 01_29_77 - Applications for Payment.

B. Format:
1. Tabular and graphic report showing anticipated earnings each month of the Contract period.
2. Base tabulation on the summation of the cost-loaded activities each month.
3. Show planned amounts.

4. Show actual earned amounts and anticipated remaining earnings.
5. Spreadsheet format of all schedule activities showing cost and percentage completion during the current month for which payment is sought.

1.16 PROGRESS SCHEDULE AND UPDATED SCHEDULE OF VALUES

A. Due date: Submit on a monthly basis as specified in Section 01_29_77 - Applications for Payment.

B. Format: As specified in Section 01_29_73 - Schedule of Values.

1.17 WEEKLY SCHEDULE

A. Due date: At every weekly progress meeting.

B. Format:
1. Contractor and Engineer must agree on the format.
2. 6-week Schedule showing the activities completed during the previous week and the Contractor's schedule of activities for following 5 weeks.
3. Use the logic and conform to the status of the current Progress Schedule when producing a weekly Schedule in CPM schedule or a bar chart format.
    a. In the event that the weekly Schedule no longer conforms to the current Schedule, Contractor may be required to revise the Schedule as specified in this Section.
4. Activity designations used in the weekly Schedule must be consistent with those used in the Baseline Schedule and the monthly Schedule updates.

1.18 LABOR HISTOGRAM

A. Due date:
1. With progress payments after Baseline Schedule has been submitted and accepted by Owner.

B. Format:
1. Labor histogram depicting total craft manpower and craft manpower for Contractor's own labor forces and those of each subcontractor.
2. Submit in electronic format.

1.19 COMMISSIONING SCHEDULE

A. Commissioning activities and milestones, as specified in Section 01_75_17 - Commissioning, shall be an integral part of the overall Progress Schedule.
1. Commissioning activities and milestones shall be extracted from the Progress Schedule to provide a separate Commissioning schedule that is submitted each time the Progress Schedule is submitted.

B. Proposed Commissioning Schedule:
1. Schedule requirements: As specified in Section 01_75_17 - Commissioning.
2. Submittal due date: Within 90 days after Notice to Proceed.

3. Engineer response due within 20 calendar days of receipt.
4. Contractor responsible for updating schedule and resubmitting within 10 calendar days of receipt of Engineer and Owner comments.

C. Construction Schedule can include the Commissioning Schedule after Engineer acceptance of the Proposed Commissioning Schedule.
1. Capable of extracting a stand-alone Commissioning Schedule.
2. Capable of extracting a stand-alone Owner Training Schedule.

D. Monthly update requirements:
1. Highlight percentages of completion, actual start and finish dates, and remaining durations, as applicable.
2. Include activities not previously included in the previously accepted detail work plan Commissioning Schedule.
3. Change Order required for any change to contractual dates.
4. Reviews of these Submittals by Engineer will not be construed to constitute acceptance within the time frames, durations, or sequence of work for each added activity.

1.20 PRE-CONSTRUCTION SCHEDULING MEETING

A. As specified in Section 01_31_19 - Project Meetings.

1.21 REVIEW AND ACCEPTANCE OF SCHEDULES

A. Engineer will review preliminary Schedules, Schedule updates, Schedule revisions, and time impact analyses to ascertain compliance with specified project constraints, compliance with milestone dates, durations and sequence, accurate inter-relationships, and completeness.

B. Engineer and Owner will issue written comments following completion of review of baseline Schedules within 21 calendar days after receipt.

C. Written comments on review of Schedule updates and Schedule revisions and time impact analyses will be returned to Contractor within 14 calendar days after receipt by Engineer.

D. Revise and resubmit Schedules in accordance with Engineer’s comments within 7 calendar days after receipt of such comments or request joint meeting to resolve objections.

E. If the Engineer requests a meeting, the Contractor and all major subcontractors shall participate.
1. Revise and resubmit Schedule within 7 calendar days after meeting.

F. Use accepted Schedules for planning, organizing, and directing the Work and for reporting progress.

G. Engineer’s Submittal review response:
1. When Schedules reflects the Owner’s and Contractor’s agreement of project approach and sequence, Schedules will be accepted by the Owner.

2. Engineer's Submittal review response for Schedule Submittals will be "Receipt Acknowledged - Filed for Record".
3. Acceptance of the Schedules by the Owner is for general conformance with the Contract Documents and for the Owner's planning information and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the Contract completion dates.
    a. Omissions and errors in the accepted Schedules shall not excuse performance less than that required by the Contract Documents.
    b. Acceptance by the Owner in no way constitutes an evaluation or validation of the Contractor's plan, sequence or means, methods, and techniques of construction.

1.22 SCHEDULE UPDATES

A. Any update:
    1. Prepare update using most recent accepted version of Schedule including:
        a. Actual start dates of activities that have been started.
        b. Actual finish dates of activities that have been completed.
        c. Percentage of completion of activities that have been started but not finished.
        d. Actual dates on which milestones were achieved.
        e. Update activities by inputting percent complete figures with actual dates.
        f. Use retained logic in preparing Schedule updates.
        g. When necessary, input remaining durations for activities whose finish dates cannot be calculated accurately with a percent complete figure only.
        h. Revisions to the Schedule may be included that have been previously approved as specified.

B. Monthly updates:
    1. Submit written narrative report in conjunction with each Schedule update, including descriptions of the following:
        a. Activities added to or deleted from the Schedule are to adhere to cost and other resource loading requirements.
            1) Identify added activities in manner distinctly different from original activity designations.
        b. Changes in sequence or estimated duration of activities.
        c. Current or anticipated problems and delays affecting progress, impact of these problems and delays and measures taken to mitigate impact.
        d. Assumptions made and activities affected by incorporating change order work into the Schedule.
        e. Include a response in writing to each of the Engineer's comments or questions from the previous month's schedule review and number responses consistent with the Engineer's numbering.
    2. Submit updated Schedule and materials specified under Submittal of Progress Schedules 5 calendar days before the monthly schedule update meeting.
    3. Since monthly Schedule update is the application for progress payment required as specified in Section 01_29_77 - Applications for Payment, submittal and acceptance of the monthly Schedule update is a condition precedent to the making of any progress payments.

C. Weekly progress meeting:
   1. Update the Schedule prior to weekly progress meeting.
      a. Identify overall progress of each major item of work in the summary schedule.
      b. If there are significant changes to the Schedule, submit a written report at the weekly progress meeting.
   2. Should monthly Schedule update show project completion earlier than current Contract completion date, show early completion time as schedule activity, identified as “Project Float”.
   3. Should monthly Schedule update show Project completion later than current Contract completion date, prepare and submit a Schedule revision.

1.23 REVISIONS TO SCHEDULES

A. Submit revised Schedules within 5 days:
   1. When delay in completion of any activity or group of activities indicates an overrun of the Contract Time or milestone dates by 20 working days or 5 percent of the remaining duration, whichever is less.
   2. When delays in Submittals, deliveries, or work stoppages are encountered making necessary the replanning or rescheduling of activities.
   3. When the Schedule does not represent the actual progress of activities.
   4. When any change to the sequence of activities, the completion date for major portions of the Work, or when changes occur which affect the critical path.
   5. When Contract modification necessitates Schedule revision, submit schedule analysis of Change Order work with cost proposal.

B. Create a separate Submittal for Schedule revisions.
   1. Comply with Schedule updates as specified in this Section.
   2. Do not submit with Schedule updates.

C. Schedule revisions will not be reflected in the Schedule until after the revision is accepted by the Owner.
   1. This includes Schedule revisions submitted for the purpose of mitigating a Contractor-caused project delay (Recovery Schedule).

1.24 ADJUSTMENT OF CONTRACT TIME OR PRICE

A. Contract Time will be adjusted only for causes specified in Contract Documents.

B. If the Contractor believes that the Owner has impacted its work such that the Project completion date will be delayed, the Contractor must submit proof, in the form of a time impact analysis demonstrating the delay to the critical path.

C. Time impact analysis:
   1. Use the accepted Schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). Represent the delay event in the Schedule by:
      a. Inserting new activities associated with the delay event into the Schedule.
      b. Revising activity logic.
      c. Revising activity durations.

2. If the Progress Schedule's critical path and completion date are impacted as a result of adding this delay event to the Progress Schedule, a time extension equal to the magnitude of the impact may be warranted.
3. The time impact analysis Submittal must include the following information:
    a. A fragment of the portion of the Schedule affected by the delay event.
    b. A narrative explanation of the delay issue and how it impacted the Schedule.
    c. A schedule file used to perform the time impact analysis.

D. When a delay to the Project as a whole can be avoided by revising preferential sequencing or logic and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.

E. Indicate clearly that the Contractor has used, in full, all project float available for the Work involved in the request, including any float that may exist between the Contractor's planned completion date and the Contract completion date.
1. Utilize the latest version of the Schedule update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.

F. Adjustment of the Contract Times will be granted only when the Contract float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date.
1. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.

G. Actual delays in activities which do not affect the Critical Path Work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the Contract Time.

H. If completion of the project occurs within the specified Contract Time, the Contractor is not entitled to job-site or home office overhead beyond the Contractor's originally planned occupancy of the site.

I. Notify Engineer of a request for Contract Time adjustment.
1. Submit request as specified in the Contract Documents.
2. In cases where the Contractor does not submit a request for Contract Time adjustment for a specific change order, delay, or Contractor request within the specified period of time, then it is mutually agreed that the particular change order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.

J. Engineer will, within 30 calendar days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the Contractor in writing.
1. Include the new Progress Schedule data, if accepted by the Owner, in the next monthly Schedule update.
2. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of

time adjustment in the Progress Schedule as the Engineer may accept as appropriate for such interim purpose.

3. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made.
4. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

1.25 WEATHER DAY ALLOWANCE

A. Allowance:
   1. Include as a separate identifiable activity on the critical path, an activity labeled “Weather Day Allowance”.

B. Actual Weather Day:
   1. Insert a weather delay activity in the critical path to reflect actual weather day occurrences when weather days are experienced and accepted by the Engineer.
   2. Reduce duration of Weather Day Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in the Weather Day Allowance at completion of the Project is considered float.
   3. Provide a written notice to the Engineer of the occurrence of a weather day within 2 days after the onset of such weather and describe in reasonable detail the type of weather encountered and the Work interfered with or interrupted.
      a. A Schedule update will not suffice as a written notice.
      b. Engineer will determine if the Weather Day constitutes a use of a portion of the Weather Day Allowance.
      c. After use of all the Weather Day Allowance, the Engineer will determine if the Contractor is entitled to an extension of the Contract Time due to weather conditions.

1.26 FINAL SCHEDULE

A. The final Schedule update becomes the As-Built Schedule.
   1. The As-Built Schedule reflects the exact manner in which the project was constructed by reflecting actual start and completion dates for all activities accomplished on the project.
   2. Contractor’s Project Manager and scheduler sign and certify the As-Built Schedule as being an accurate record of the way the project was actually constructed.

B. Retainage will not be released until final Schedule update is provided.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_32_34

PHOTOGRAPHIC AND VIDEOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for photographs and videos.

B. The purpose of the photographs and videos is to document the condition of the facilities prior to the Contractor beginning work at the Project site, the progress of the Work, and the Project site after Substantial Completion of the Work.

C. The scope of the photographic and videographic documentation shall be the sole responsibility of the Contractor but shall be acceptable to the Engineer.

1.02 SUBMITTALS

A. Photographer qualifications.

B. Pre-construction photographs and videos: Submit prior to beginning work at the Project site or prior to the Preconstruction Conference specified in Section 01_31_19 - Project Meetings, whichever occurs earlier.

C. Construction photographs and videos: Submit with each application for payment.

D. Post-construction photographs and videos: Submit with project closeout documents as specified in Section 01_77_00 - Closeout Procedures.

1.03 PHOTOGRAPHER

A. Photographer qualified and equipped to photograph either interior or exterior exposures, with lenses ranging from wide angle to telephoto.

B. Submit example work of previous photographs and video recording meeting the requirements of this Section.
   1. Provide to Engineer no later than the pre-construction conference.
   2. Provide photographs used for site examination.
   3. Provide video of site examination.
   4. Provide samples that used same camera and lighting equipment proposed for the Work.
   5. Engineer will review work examples to determine if the quality of the images is acceptable.
   6. Contractor is responsible for modifications to equipment and/or inspection procedures to achieve report material of acceptable quality.
   7. Do not commence Work prior to approval of the material by the Engineer.
   8. Once accepted, the standard report material shall serve as a standard for the remaining work.

1.04 KEY PLAN

A. Submit key plan of Project site with notation of vantage points marked for location and direction of each photograph.

B. Include the same label information as the corresponding set of photographs.

1.05 PHOTOGRAPHS

A. Provide prints of each photograph for each area of Work.

B. Provide a digital copy of each photograph for each area of Work.
   1. Monthly: Indexed digital flash drive.
   2. Project record documents:
      a. Catalog and index prints in chronological sequence.
      b. Include typed table of contents.

1.06 PRE-CONSTRUCTION PHOTOGRAPHS AND VIDEOS

A. Provide photographs and video of the condition entire site including each area of Work prior to the start of Work.
   1. Areas to be photographed and videoed shall include the site of the Work and all existing facilities, either on or adjoining the Project site, including the interior of existing structures that could be damaged as a result of the Contractor's Work.
   2. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.

1.07 CONSTRUCTION PHOTOGRAPHS AND VIDEOS

A. Time-Lapse Video:
   1. Identification: For each recording, provide the following information on web-based project software site:
      a. Name of Project.
      b. Owner: City of Bellingham.
      c. Name of Engineer/Construction Manager.
      d. Name of Contractor.
      e. Name and contact information for photographer.
      f. Date(s) and time(s) video recording was recorded.
      g. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
   2. Frequency of time-lapse photos: 1 each workday at 9 am and 3 pm.
   3. Duration of time-lapse photos: 20 seconds.
   4. Access to video:
      a. Submit to web-based construction project management system monthly.

B. Provide photographs and videos of construction in each area of Work throughout progress of Work including a key plan designating where each photograph was taken.

C. Take site and interior photographs and videos from differing directions of building demolition, pre-excavation, footing excavation, soil testing, utility crossings, installation of bypass piping, excavation of access pits, installation of lining system in pipes, rehabilitation of manholes, building modifications, utilities, electrical and instrumentation modifications, and other applicable activities indicating relative progress of the work.

D. Take photos a maximum of 7 calendar days prior to Submittal.

1.08 POST-CONSTRUCTION PHOTOGRAPHS AND VIDEOS

A. Provide photographs of the entire site including each area of Work at the completion of Work.
   1. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.
   2. Take photos and video from same points in same direction as pre-construction examination.

B. Submittal of photos and videos is a condition of final payment.

PART 2 PRODUCTS

2.01 MEDIA

A. Paper media:
   1. Commercial grade, glossy surface, acid-free photographic paper.
   2. Submit 3 prints of each photographic view within 7 days of taking photographs.
   3. Format:
      a. Ground photos: Color, matte finish, 8-1/2-inch by 11-inch size, mounted on soft card stock.
      b. Aerial photos: Color, matte finish, 11-inch by 17-inch size, mounted on soft card stock.
      c. Mount each print in a separate, archival type, non-glare, 3-hole punched protector.
   4. Identification: On photograph, provide the following information:
      a. Name of project.
      b. Date stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
      c. Description of vantage point, indicating location and direction by compass point.
   5. Provide a suitably sized 3-ring binder for each set of prints.
      a. Furnish binders in sufficient quantities to hold entire set of prints taken for the duration of the Contract.
      b. Label binder spine and front with project name.

B. Digital media:
   1. Flash drive compatible with current Microsoft Windows.
   2. Provide photos as individual, indexed JPG files with the following characteristics:
      a. Compression shall be set to preserve quality over file size.

b. Highest resolution JPG images shall be submitted. Resizing to a smaller size when high resolution JPGs are available shall not be permitted.
c. JPG image resolution shall be 5 megapixels at 2,400 by 1,800 or higher.
d. Images shall have rectangular, clean images. Artistic borders, beveling, drop shadows, etc., are not permitted.

3. Identification: On photograph, provide the following information:
   a. Name of project.
   b. Date stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
   c. Description of vantage point, indicating location and direction by compass point.

C. Videos:
1. Video quality shall be 720p HD or greater in MPG, AVCHD, AVI, or MP4 format.
2. Digital color video format.
3. Provide audio portion of the composite video sufficiently free from electrical interference and background noise to provide complete intelligibility of oral report.
4. Identification: On each copy provide a label with the following information:
   a. Name of project.
   b. Date video was recorded.
5. Submit 1 copy of each video within 7 days of recording.
6. Display continuous running time.
7. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_33_00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements and procedures for Submittals to confirm compliance with Contract Documents.

1.02 GENERAL INSTRUCTIONS

A. Contractor is responsible to determine and verify field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and check and coordinate each item with other applicable approved Shop Drawings and Contract Document requirements.

B. Provide Submittals:
   1. That are specified or reasonably required for construction, operation, and maintenance of the Work.
   2. That demonstrate compliance with the Contract Documents.

C. Where multiple Submittals are required, provide a separate Submittal for each Specification section.
   1. In order to expedite construction, the Contractor may make more than one Submittal per Specification section, but a single Submittal may not cover more than one Specification section:
      a. The only exception to this requirement is when one Specification section covers the requirements for a component of equipment specified in another section.
      b. For example, circuit breakers are a component of switchgear. The switchgear Submittal must also contain data for the associated circuit breakers, even though they are covered in a different Specification section.

D. Prepare Submittals in the English language. Do not include information in other languages.

E. Present measurements in customary American units (feet, inches, pounds, etc.).

F. Must be clear and legible, and of sufficient size for presentation of information.

G. Page size, other than drawings:
   1. Minimum: 8-1/2 inches by 11 inches.
   2. Maximum: 11 inches by 17 inches.

H. Drawing sheet size:
   1. Maximum: 22 inches by 34 inches.
      a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
      b. Minimum font size: 1/8-inch.
   2. 11-inch by 17-inch sheet:
      a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
      b. Minimum font size: 1/8-inch.

I. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.

J. Provide Submittal information from only one manufacturer for a specified product. Submittals with multiple manufacturers for one product will be rejected without review.

1.03 SUBMITTAL ORGANIZATION

A. Organize Submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification section.

B. For Submittals that cover multiple devices used in different areas under the same Specification section, the Submittal for the individual devices must list the area where the device is used.

C. Bookmarks:
   1. Bookmarks shall match the table of contents.
   2. Bookmark each section (tab) and heading.
   3. Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
   4. At file opening, display all levels of bookmarks as expanded.

D. Where applicable (i.e., except for Drawings, figures, etc.), Submittal content shall be electronically searchable utilizing the PDF file as submitted.

E. Thumbnails optimized for fast web viewing.

F. Sequentially number pages within the tabbed sections:
   1. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.

G. Attachments:
   1. Include with each Submittal a copy of the relevant Specification section.
      a. Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
   2. Include with each Submittal a copy of the relevant Drawing, including relevant addendum updates.
      a. Indicate either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).

b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.

H. Contractor: Prepare Submittal information in sufficient detail to show compliance with specified requirements.
1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
2. Coordinate Submittal with other Submittals and with the requirements of the Contract Documents.
3. Check, verify, and revise Submittals as necessary to bring them into conformance with Contract Documents and actual field conditions.

I. Contractor: Prepare “Or Equal” Submittal information.
1. Provide standard Submittal requirements.
a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
2. Provide reason the specified product is not being provided.
3. Explain the benefits to the Owner for accepting the “Or Equal”.
4. Itemized comparison of the proposed “Or Equal” with product specified, including a list of significant variations:
a. Design features.
b. Design dimensions.
c. Installation requirements.
d. Operations and maintenance requirements.
e. Availability of maintenance services and sources of replacement materials.
5. Reference projects where the product has been successfully used:
a. Name and address of project.
b. Year of installation.
c. Year placed in operation.
d. Name of product installed.
e. Point of contact: Name and phone number.
6. Define impacts:
a. Impacts to other contracts.
b. Impacts to other work or products.
7. Contractor represents the following:
a. Contractor bears the burden of proof of the equivalency of the proposed “Or Equal”.
b. Proposed “Or Equal” is equal or superior to the specified product.
c. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed “Or Equal”, unless the Owner requires a Special Warranty.
d. Contractor will coordinate installation of accepted “Or Equal” into the Work and will be responsible for the costs to make changes as required to the Work.
e. Contractor waives rights to claim additional costs caused by proposed “Or Equal” which may subsequently become apparent.

J. Contractor: Prepare substitution Submittal information.
    1. Provide standard Submittal requirements.
        a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
    2. Provide reason the specified product is not being provided.
    3. Explain the benefits to the Owner for accepting the substitution.
    4. Itemized comparison of the proposed substitution with product specified, including a list of significant variations:
        a. Design features.
        b. Design dimensions.
        c. Installation requirements.
        d. Operations and maintenance requirements.
        e. Availability of maintenance services and sources of replacement materials.
    5. Reference projects where the product has been successfully used:
        a. Name and address of project.
        b. Year of installation.
        c. Year placed in operation.
        d. Name of product installed.
        e. Point of contact: Name and phone number.
    6. Define impacts:
        a. Impacts to Contract Price.
            1) Required license fees or royalties.
            2) Do not include costs under separate contracts.
            3) Do not include Engineer’s costs for redesign or revision of Contract Documents.
        b. Impacts to Contract Time.
        c. Impacts to Contract Scope.
        d. Impacts to other contracts.
        e. Impacts to other work or products.
    7. Contractor represents the following:
        a. Contractor shall pay associated costs for the Engineer to evaluate the substitution.
        b. Contractor bears the burden of proof of the equivalency of the proposed substitution.
        c. Proposed substitution does not change the design intent and will have equal performance to the specified product.
        d. Proposed substitution is equal or superior to the specified product.
        e. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed substitution, unless the Owner requires a Special Warranty.
        f. Contractor will coordinate installation of accepted substitution into the Work and will be responsible for the costs to make changes as required to the Work.
        g. Contractor waives rights to claim additional costs caused by proposed substitution which may subsequently become apparent.

1.04 SUBMITTAL IDENTIFICATION NUMBERING

A. Number each Submittal using the format defined in the table below:

	Spec Section Number	Dash	Initial Submittal - Sequential Number	Decimal Point	Subsequent Submittal Revisions Sequential Number
Example 1 Description	*Cast-In-Place Concrete*		*8th initial Submittal*		
	03_30_00	-	0008		
Example 2 Description	*Cast-In-Place Concrete*		*8th initial Submittal*		*First revision to the 8th initial Submittal*
	03_30_00	-	0008	.	1

1.05 SUBMITTALS IN ELECTRONIC MEDIA FORMAT

A. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.

B. Text: Provide text documents and manufacturer's literature in Portable Document Format (PDF).

C. Graphics: Provide graphic Submittals (Drawings, diagrams, figures, etc.) utilizing Portable Document Format (PDF).

1.06 SUBMITTAL PROCEDURE

A. Engineer: Review Submittal and provide response:
   1. Review description:
      a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular Submittal whether or not a stamp or seal is required by Contract Documents or Laws and Regulations.
      b. Engineer's review of Submittals shall not release the Contractor from the Contractor's responsibility for performance of requirements of Contract Documents. Neither shall the Engineer's review release the Contractor from fulfilling purpose of installation nor from the Contractor's liability to replace defective Work.
      c. Engineer's review of Shop Drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in Contract Documents.
      d. Engineer's review does not extend to:
         1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by the Contractor.

2) Contractor's means, methods, techniques, sequences, or procedures, except when specified, indicated on the Drawings, or required by Contract Documents.
3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Contractor.

e. Engineer can Approve or Not Approve any exception at their sole discretion.

2. Review timeframe:
   a. Except as may be provided in technical Specifications, a Submittal will be returned within 30 days.
   b. When a Submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the Submittal, give notice of the date by which that Submittal will be returned.
   c. Engineer's acceptance of progress schedule containing Submittal review times less than those specified or agreed to in writing by the Engineer will not constitute Engineer's acceptance of review times.
   d. Critical Submittals:
      1) Contractor will notify Engineer in writing that timely review of a Submittal is critical to the progress of Work.
3. Schedule delays:
   a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer's review of Submittals unless all of the following criteria are met:
      1) Engineer has failed to review and return first submission within the agreed upon time frame.
      2) Contractor demonstrates that delay in progress of Work is directly attributable to the Engineer's failure to return Submittal within time indicated and accepted by the Engineer.
4. Review response will be returned to the Contractor with one of the following dispositions:
   a. Approved:
      1) No Exceptions:
         a) There are no notations or comments on the Submittal and the Contractor may release the equipment for production.
      2) Make Corrections Noted - See Comments:
         a) Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
         b) Resubmittal not required.
      3) Make Corrections Noted - Confirm:
         a) Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
         b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.
   b. Not Approved:
      1) Correct and Resubmit:
         a) Contractor may not proceed with the Work described in the Submittal.
         b) Contractor assumes responsibility for proceeding without approval.
         c) Resubmittal of complete Submittal package is required within 30 calendar days of the date of the Engineer's Submittal review response.

2) Rejected - See Remarks:
    a) Contractor may not proceed with the Work described in the Submittal.
    b) Submittal does not meet the intent of the Contract Documents. Resubmittal of complete Submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.

c. Receipt Acknowledged:
    1) Filed for Record:
        a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.
    2) With Comments - Resubmit:
        a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc. Feedback regarding missing information, conflicting information, or other information that makes it incomplete can be made with comments.

B. Contractor: Prepare resubmittal, if applicable:
1. Clearly identify each correction or change made. Provide page references to the changed information within the resubmittal.
2. Include a response in writing to each of the Engineer's comments or questions for Submittal packages that are resubmitted in the order that the comments or questions were presented from the first and subsequent Submittals and numbered consistent with the Engineer's numbering.
    a. Acceptable responses to the Engineer's comments are listed below:
        1) "Incorporated" - Engineer's comment or change is accepted and appropriate changes are made.
        2) "Response" - Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by the Engineer.
    b. Reviews and resubmittals:
        1) Contractor shall provide resubmittals which include responses to all Submittal review comments separately and at a level of detail commensurate with each comment.
        2) Contractor responses shall indicate how the Contractor resolved the issue pertaining to each review comment
            a) Responses such as "acknowledged" or "noted" are not acceptable.
        3) Resubmittals which do not comply with this requirement may be rejected and returned without review.
        4) Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant Submittals.
        5) Submittal review comments not addressed by the Contractor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Contractor to the satisfaction of the reviewing and approving authority.

c. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for revision and resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.

3. Resubmittal timeframe:
   a. Contractor shall provide resubmittal within 15 days.
   b. When a resubmittal cannot be returned within the specified period, Contractor shall notify the Engineer in writing.
4. Review costs:
   a. Costs incurred by the Owner as a result of additional reviews of a particular Submittal after the second time it has been reviewed shall be borne by the Contractor.
   b. Reimbursement to the Owner will be made by deducting such costs from the Contractor's subsequent progress payments.

1.07 PRODUCT DATA

A. Edit Submittals so that the Submittal specifically applies to only the product furnished.

B. Neatly cross out all extraneous text, options, models, etc., that do not apply to the product being furnished so that the information remaining is only applicable to the product being furnished.

1.08 SHOP DRAWINGS

A. Contractor to field verify elevation, coordinates, and pipe material for pipe tie-in to pipeline or structure prior to the preparation of Shop Drawings.

B. Indicate project-designated equipment tag numbers for Submittal of devices, equipment, and assemblies.

1.09 SAMPLES

A. Details:
   1. Submit labeled samples.
   2. Samples will not be returned.
   3. Provide number of sample Submittals as below:
      a. Total: 3 minimum.
         1) Owner: 1.
         2) Engineer: 2.
         3) Contractor: None.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - CONTRACTOR SUBMITTAL TRANSMITTAL FORM

CONTRACTOR SUBMITTAL TRANSMITTAL FORM

Owner:	Click here to enter text.	**Date:**	MM/DD/YYYY
Contractor:	Click here to enter text.	**Project No.:**	XXXXX.XX
Project Name:	Click here to enter text.	**Submittal Number:**	000
Submittal Title:	Click here to enter text.		
To:	Click here to enter text.		
From:	Click here to enter text.	Click here to enter text.	
	Click here to enter text.	Click here to enter text.	

Specification No. and Subject of Submittal/Equipment Supplier			
Spec ##:	Spec ##.	**Subject:**	Click here to enter text.
Authored By:	Click here to enter text.	**Date Submitted:**	XX/XX/XXXX

Submittal Certification	
Check Either (A) or (B):	
☐	(A) We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings with no exceptions.
☐	(B) We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings, except for the deviations listed.
Certification Statement: By this Submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved Shop Drawings and all Contract requirements.	
General Contractor's Reviewer's Signature:	
Printed Name:	

PM/CM Office Use	
Date Received GC to PM/CM:	
Date Received PM/CM to Reviewer:	
Date Received Reviewer to PM/CM:	
Date Sent PM/CM to GC:	

SECTION 01_35_21

SELECTIVE ALTERATIONS AND DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cutting or modifying of existing and new work.
   2. Partial demolition of structures.
   3. In-place abandonment of pipe.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A10.6 - Safety and Health Program Requirements for Demolition Operations.

B. International Concrete Repair Institute (ICRI):
   1. Guideline No. 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
   2. Guideline No. 310.3R - Guide for the Preparation of Concrete Surfaces for Repair Using Hydrodemolition Methods.

1.03 DEFINITIONS

A. Chipping hammer: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight of less than 15 pounds and an impact frequency of greater than 2,000 blows/minute.

B. Concrete breaker: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight greater or impact frequency less than the limits defined for a chipping hammer.

C. Coring equipment: Non-impact rotary drill with diamond cutting edges.

D. Heavy abrasive blast: Cleaning procedure by which various abrasives materials, or steel shot, are forcibly propelled by high pressure against a surface to remove loose material and produce a concrete surface roughened to ICRI Surface Profile CSP-7, or higher, as specified in ICRI 301.3R.

E. Salvage material: Materials removed from existing facilities and stored for Owner's future reuse.

1.04 DESCRIPTION OF WORK

A. The work includes partial demolition, cutting, and modifying of existing facilities, utilities, and/or structures.

B. These facilities may be occupied and/or operational. Satisfactory completion of the work will require that the Contractor plan activities carefully to work around unavoidable obstacles and to maintain overall stability of structures and structural elements. It will further require restoration of existing facilities, utilities, and structures that are to remain in place and that are damaged by demolition or removal operations.

1.05 SUBMITTALS

A. General:
   1. Submit specified in Section 01_33_00 - Submittal Procedures.

B. Shop drawings: Include:
   1. The location of all embedded items shall be documented using diagrams and/or other media that clearly show dimensions and locations of existing structural elements, existing embedded items and any new embedded items and their relationship to each other.

C. Submittals for information only:
   1. Permits and notices authorizing demolition.
   2. Certificates of severance of utility services.
   3. Permit for transport and disposal of debris.
   4. Selective Demolition Plan.
   5. Pipe Abandonment Plan.

D. Quality assurance submittals:
   1. Qualifications of non-destructive testing agency/agencies.

E. Project record documents.

F. Drawings and/or other media documenting locations of service lines and capped utilities.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Assign relocation, removal, cutting, coring and patching to trades and workers qualified to perform the Work in manner that causes the least damage and that provides means of returning surfaces to an appearance at least equal to that of the surrounding areas unaffected by the Work.
   2. Non-destructive testing agencies: Minimum of 5 years' experience performing non-destructive testing for location of steel reinforcement in existing concrete under conditions similar to that required for this Work.

1.07 SEQUENCING

A. Perform Work in sequences and within times specified in Section 01_14_00 - Work Restrictions.

B. If the facility or utility to be modified cannot be removed from service, perform the Work while the facility is in operation using procedures and equipment that do not jeopardize operation or materially reduce the efficiency of that facility.

C. Coordinate the Work with operation of the facility:
   1. Do not begin alterations of designated portions of the Work until specific permission for activities in each area has been granted by Owner in writing.
   2. Complete Work as quickly and with as little delay as possible.

D. Operational functions of the facility that are required to be performed to facilitate the Work will be performed by facility personnel only.

E. Owner will cooperate to assist in expediting the Work.

F. When necessary for the proper operation or maintenance of portions of the facility, reschedule operations so the Work will not conflict with required operations or maintenance.

1.08 REGULATORY REQUIREMENTS

A. Dispose of debris in accordance with governing regulatory agencies.

B. Comply with applicable air pollution control regulations.

C. Obtain permits for building demolition, transportation of debris to disposal site and dust control.

1.09 PREPARATION

A. Non-destructive evaluation of existing concrete and masonry:
   1. Prior to cutting, drilling, coring, and/or any other procedure that penetrates existing concrete or masonry, retain and pay for the services of a qualified non-destructive testing agency to perform investigations to determine the location of existing steel reinforcement, plumbing, conduit, and/or other embedments in the concrete.
   2. Submit documentation of the investigations to the Engineer for review and approval as specified in Section 01_33_00 - Submittal Procedures, before any work involving penetration of existing concrete is initiated.

B. Obtain permission from adjacent property owners when outriggers, swinging cranes, and other equipment may have to traverse or extend into adjacent property.

1.10 PROJECT CONDITIONS

A. Do not interfere with use of adjacent structures and elements of the facility not subject to the Work described in this Section. Maintain free and safe passage to and from such facilities.

B. Provide, erect, and maintain barricades, lighting, guardrails, and protective devices as required to protect building occupants, general public, workers, and adjoining property:
   1. Do not close or obstruct roadways without permits.
   2. Conduct operations with minimum interference to public or private roadways.

C. Prevent movement, settlement, or collapse of structures adjacent services, sidewalks, driveways and trees:
   1. Provide and place bracing or shoring.
   2. Cease operations and notify Engineer immediately when safety of structures appears to be endangered. Take precautions to properly support structure. Do not resume operations until safety is restored.
   3. Assume liability for movement, settlement, or collapse. Promptly repair damage.

D. Arrange and pay for capping and plugging utility services. Disconnect and stub off.
   1. Notify affected utility company in advance and obtain approval before starting demolition.
   2. Place markers to indicate location of disconnected services.

E. Unknown conditions:
   1. The drawings may not represent all conditions at the site and adjoining areas. Compare actual conditions with drawings before commencement of Work.
   2. Existing utilities and drainage systems below grade are located from existing documents and from surface facilities such as manholes, valve boxes, area drains, and other surface fixtures.
   3. If existing active services encountered are not indicated or otherwise made known to the Contractor and interfere with the permanent facilities under construction, notify the Engineer in writing, requesting instructions on their disposition. Take immediate steps to ensure that the service provided is not interrupted, and do not proceed with the Work until written instructions are received from the Engineer.

PART 2 PRODUCTS

2.01 SALVAGE MATERIALS

A. Materials designated for salvage:
   1. None.

B. Handling and storage:
   1. Prevent damage to salvaged materials during removal, handling, and transportation.

2. Prepare salvaged materials for storage:
    a. Not applicable.
3. Store salvaged materials in the following locations:
    a. Not applicable.

C. Pay costs associated with salvaging materials, including handling, transporting, and storage.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to beginning selective demolition operations, perform a thorough inspection of the facility and site.
    1. Report to the Engineer defects, structural damage, and deterioration of existing construction to remain in place.

B. Examine areas affected by the Work and verify the following conditions prior to commencing demolition:
    1. Disconnection of utilities as required.
    2. Verify that utilities serving occupied or active portions of surrounding facilities will not be disturbed, except as otherwise indicated.

C. If unsatisfactory conditions exist, notify the Engineer, and do not begin demolition operations until such conditions have been corrected.

3.02 PREPARATION

A. Plan and organize Work to minimize inconvenience to adjacent buildings and to plant operations.

B. Selective Demolition Plan:
    1. Prepare and submit a comprehensive selective demolition plan for the Work including the following elements, at a minimum:
        a. Proposed sequence, methods, temporary support, and equipment for demolition, removal, and disposal of portions of structure(s).
        b. Provisions and procedures for salvage and delivery to Owner of salvaged items, if required.
    2. Submit plan a minimum 4 weeks before demolition is scheduled to begin.

C. Pipe Abandonment Plan:
    1. Prepare and submit a comprehensive Pipe Abandonment Plan for the Work.
        a. Include provisions to demonstrate and verify with camera inspection that all solids have been removed and that pipe is free of residuals.
    2. At a minimum, define the following elements:
        a. Proposed sequence, methods, cleaning procedures, or demolition, removal, and disposal of contents of the piping.
        b. Method of verification of final pipe condition.
        c. Detailed drawings showing treatment of pipe ends.
    3. Submit plan a minimum 4 weeks before abandonment is scheduled to begin.

D. Protection:
   1. Erect weatherproof closures to protect the interior of facilities and elements or equipment that are not designed for exposure to the weather.
   2. Provide temporary heat, cooling, and humidity control as necessary to prevent damage to existing and new equipment and construction.
   3. Maintain existing exiting paths and/or provide new paths in compliance with Building Code requirements.
   4. Erect and maintain dustproof partitions as required to prevent spread of dust, to other parts of building. Maintain negative pressure in the area where the Work is being performed to prevent the accidental spread of dust and to minimize the spread of fumes related to the Work.
   5. Upon completion of Work, remove weatherproof closures and dustproof partitions.
   6. Repair damaged surfaces to match adjacent surfaces.
   7. Provide and maintain protective devices to prevent injury from falling objects.
   8. Locate guardrails in stairwells and around open shafts to protect workers. Post clearly visible warning signs.
   9. Protect the following from damage or displacement during Work.
      a. Benchmarks and survey points.
      b. Existing construction that will remain in place.
      c. Trees and landscaping designated to remain in place.
   10. Carefully remove designated materials and equipment to be salvaged by Owner or reinstalled.
   11. Store and protect materials and equipment to be reinstalled.

E. Layout:
   1. The limits of selective demolition are indicated on the Drawings. Confine demolition operations within the limits indicated on the Drawings.
   2. Lay out demolition and removal work at the site and coordinate with related Work for which demolition and removal is required.
   3. Clearly mark the extent of structural elements to be removed on the actual surfaces that will be removed.
   4. Arrange for Engineer's inspection of the lay out extents.
   5. Do not begin demolition/removal operations until the lay out markings have been reviewed by the Engineer.

3.03 DEMOLITION

A. General:
   1. Perform demolition work in accordance with ANSI A10.6.
   2. Demolish designated portions of structures and appurtenances in orderly and careful manner in accordance with the Selective Demolition Plan.
   3. Conduct demolition and removal work in a manner that will minimize dust and flying particles.
      a. Use water or dust palliative when necessary to prevent airborne dust.
      b. Provide and maintain hoses and connections to water main or hydrant.
   4. Remove materials carefully, to the extent indicated and as required.
      a. Provide neat and orderly junctions between existing and new materials.
      b. Use methods that terminate surfaces in straight lines at natural points of division.

5. Do not remove anything beyond the limits of Work indicated without prior written authorization from the Engineer.
    a. If in doubt about whether to remove an item, obtain written authorization from the Engineer prior to proceeding.
6. Perform work so as to provide the least interference and most protection to existing facilities to remain.
7. Demolished materials:
    a. Assume possession of materials unless otherwise indicated on the Drawings or specified.
    b. Owner claims the following materials:
        1) Valves.
        2) Circuit breakers.
        3) Programmable logic controllers.
        4) Fuses.
        5) Wire.
    c. Remove demolished materials from site at least weekly and dispose of them in accordance with Laws and Regulations.
    d. Do not burn or bury materials on site.

B. Demolition of concrete and masonry:
1. Demolish concrete and masonry in small sections.
    a. Perform demolition with small tools as much as possible.
    b. Blasting with explosive charges is not permitted.
2. Sawcut concrete to establish the edges of demolition, wherever possible.
    a. Do not use a concrete breaker within 6 inches of reinforcing or structural metals that are designated to remain in place.
    b. At edges that are not sawcut, remove the final 6 inches of material with a chipping hammer as defined herein. At surfaces where material is removed with a chipping hammer, follow with a heavy abrasive blast to remove all loose material and microcracking.
    c. Alternate techniques to remove concrete may be used if acceptable to the Engineer; however, techniques other than those deemed by ICRI Guideline No. 310.2R to provide a low risk of introducing microcracking will require a subsequent procedure to remove loose material and microcracked.
    d. Provide final surface preparation for repairs as specified and indicated on the Drawings.
3. At locations indicated on the Drawings where the existing reinforcing is to be preserved, remove concrete using methods that do not damage the reinforcing. Use one of the following techniques:
    a. Hydrodemolition techniques as outlined in ICRI Guideline No. 310.3R.
    b. Chipping hammer, as defined herein, followed by heavy abrasive blast to remove all loose material and microcracking at remaining surfaces impacted by the chipping hammer.
    c. Alternate methods may be used, only when accepted in advance by the Engineer.
    d. For all methods, provide a small completed area for Engineer's review and acceptance. If the proposed method, in the opinion of the Engineer, damages the reinforcing, revise the removal method to remove the concrete with a less aggressive technique to protect the reinforcing.

C. Sizing of openings in existing concrete or masonry:
    1. Make openings large enough to permit final alignment of pipe and fittings without deflections, but without oversizing.
    2. Allow adequate space for packing around pipes and conduit to ensure watertightness.
    3. If the Engineer deems the opening to be insufficient in size to accomplish this criteria, remove additional material using the procedures outlined in this Section.

D. Cutting openings in existing concrete or masonry:
    1. Do not allow saw cuts to extend beyond limits of openings.
    2. Create openings by the following method or other means acceptable to the Engineer that prevents over-cutting of member at corners:
        a. Core-drill through slab or wall at corners, being careful not to damage materials beyond the area to be removed.
        b. Saw cut completely through the member, between the core holes at the corners.
        c. As an alternate to sawcutting through the member, score the edges of the opening with a saw to a 1-inch depth.
            1) Provide score on both surfaces (when accessible).
            2) Remove concrete or masonry to within 6 inches of material to remain with a concrete breaker.
            3) Remove the remaining material with a chipping hammer.
        d. Remove the remaining material at the corners left by the core-drilling with a chipping hammer.
    2. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.

E. In-place Abandonment of Pipe:
    1. Abandoned pipe in-place as indicated on the Drawings.
    2. Clean buried or exposed solids service piping to a condition free of residual.
        a. Solids service piping includes: raw wastewater (RAW WW), primary sludge or scum (PS), mixed liquor (ML), return activated sludge (RAS), waste active sludge (WAS), surface waste activated sludge (SWAS), thickened waste activated sludge (TWAS), digested sludge (DS), centrate, or other similar solids service subject to biological degradation, etc.
    3. Provide closure of abandoned pipe cut ends as indicated on the Drawings using one of the following methods:
        a. Leave one end open.
        b. Install cap.
        c. Install plug.
        d. Install drain valves, pressure relief valves, vents, etc.]
        e. Fill abandoned pipe as specified in Section 31_23_24 - Controlled Low Strength Material (CLSM).

F. Buried structures:
        a. Pump out buried tanks.

G. Immediately upon discovery, remove and dispose of contaminated, vermin-infested, or dangerous materials using safe means that will not endanger health of workers and public.

H. Backfill open pits and holes caused by demolition as specified in Section 31_00_00 - Earthwork.

I. Rough grade areas affected by demolition.

J. Remove demolished materials, tools, and equipment upon completion of demolition.

3.04 RESTORATION

A. General:
   1. Repair damage caused by demolition to conditions equal to those that existed prior to beginning of demolition.
      a. Patch and replace portions of existing finished surfaces that are damaged, lifted, and discolored. Refinish patched portion surfaces in a manner which produces uniform color and texture to entire surface, and that matches color and texture of adjacent surfaces.
      b. When existing finish cannot be matched, refinish entire surface to nearest change of plane where angle of change exceeds 45 degrees.
   2. The cost of repairs shall be at the Contractor's expense at no increase in the Contract Price.
   3. When new construction abuts or finishes flush with existing construction, make smooth transitions. Match finish of existing construction.
   4. Where partitions are removed, patch floors, walls, and ceilings with finish materials that match existing materials.
   5. Where removal of partitions results in adjacent spaces becoming one, rework floors, walls, and ceilings to provide smooth planes without breaks, steps, or bulkheads.
      a. Where change of plane between adjacent surfaces exceeds 2 inches, request and obtain instructions for making transition from Engineer.
         1) Refinish door surfaces and edges as necessary.
   6. Trim existing doors as necessary to clear new floors.
   7. Match patched construction with adjacent construction in texture and appearance so that patch or transition is invisible at 5-foot distance.
   8. When finished surfaces are cut so that smooth transition is impossible, terminate existing surface in neat manner along straight line at natural line of division and provide appropriate trim.

B. Restore existing concrete reinforcement as follows:
   1. Where existing reinforcement is to be incorporated into the new Work, protect, clean, and extend into new concrete.
   2. Where existing reinforcement is not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line will become the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

C. Restore areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, conduits, and fasteners so little or no evidence of the previous installation remains:
   1. After removal of piping, conduit, fasteners, and other construction, fill areas in existing concrete and masonry floors, walls, and ceilings with non-shrink grout and finish smooth.
   2. Remove concrete bases for equipment and supports by:
      a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface.
         1) Do not cut existing reinforcement in slab.
      b. Chip concrete within scored lines.
      c. Cut exposed reinforcing steel and anchor bolts that will project above the repaired surface.
      d. Patch with non-shrink grout to match adjacent grade and finish.
   3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.
   4. Where existing fasteners are not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut fasteners flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line will become the finished surface, cut fasteners 1 inch below the surface, paint ends with epoxy, and patch holes with epoxy grout.

3.05 FIELD QUALITY CONTROL

A. Do not proceed with demolition without Engineer's inspection of lay out.

B. Do not deviate from the submitted demolition plan without notifying the Engineer prior to Work.

END OF SECTION

SECTION 01_35_44

HAZARDOUS MATERIAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Procedures required when encountering hazardous materials at the Work site.
   2. Appendix A hazardous material report.

1.02 REFERENCES

A. Occupational Safety and Health Administration (OSHA).

B. United States Code of Federal Regulation (CFR):
   1. Title 29 - Labor:
      a. 1926.62 - Lead.
   2. Title 40 - Protection of Environment:
      a. 261 - Identification and Listing of Hazardous Waste.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Adequately wet: Penetration of the pipe wall with liquid to prevent release of particulates.
   2. Asbestos cement pipe: Also commonly referred to as AC transite pipe, AC pipe or ACP. Pipe that is generally composed of cement and asbestos fibers.
   3. Competent person: A trained worker who is capable of identifying existing and predictable asbestos hazards, perform exposure assessment and monitoring, is qualified to train other workers, and has the authority to take immediate corrective action to eliminate a hazardous exposure.
   4. Non-friable asbestos-containing material (NACM): Material containing more than 1 percent asbestos, that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.
   5. Regulated asbestos-containing material (RACM): Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder in the course of work.

1.04 SUBMITTALS

A. Submit laboratory reports, hazardous material removal plans, and certifications.

B. Submit the following work plan:
   1. Removal and Legal Disposal of Asbestos Cement Pipe Plan.
      a. Work plan shall include, but not be limited, to the following:
         1) Schedule of work.

2) Security measures for work and disposal area.
3) Staff training: Provide at least one competent person who is capable of identifying asbestos hazards at the job site for the entire duration of the AC pipe removal and disposal operation.
4) Trenching and removal of pipe procedure.

1.05 HAZARDOUS MATERIALS PROCEDURES

A. Hazardous materials are those defined by 40 CFR and State specific codes.

B. Forward to Engineer, copies of reports, permits, receipts, and other documentation related to remedial work.

C. Assume responsibility for worker health and safety, including health and safety of Subcontractors and their workers.
   1. Instruct workers on recognition and reporting of materials that may be hazardous.

D. File requests for adjustments to Contract Times and Contract Price due to the finding of Hazardous Materials in the Work site in accordance with Contract Documents.
   1. Minimize delays by continuing performance of the Work in areas not affected by hazardous materials operations.

E. When hazardous materials have been found:
   1. Prepare and initiate implementation of plan of action.
   2. Notify immediately Owner, Engineer, and other affected persons.
   3. Notify such agencies as are required to be notified by laws and regulations with the times stipulated by such laws and regulations.
   4. Designate a Certified Industrial Hygienist to issue pertinent instructions and recommendations for protection of workers and other affected persons' health and safety.
   5. Identify and contact Subcontractors and licensed personnel qualified to undertake storage, removal, transportation, disposal, and other remedial work required by, and in accordance with, laws and regulations.

1.06 LEAD PAINT REMOVAL AND DISPOSAL

A. Existing paint on the interior surfaces that may contain lead in concentrations which will require implementation of hazardous material compliance procedures as legislated by the following:
   1. CFR, Title 29 and Title 40.

B. Remove samples of paint from the structures identified in this Section and have samples tested by a certified testing laboratory to determine lead content in samples.
   1. Ensure that sufficient numbers of paint samples are removed and tested to provide adequate information regarding lead content in paint.
   2. Ensure that samples contain the total thickness of the paint to the substrate where removed.

3. Ensure that each sample contains a sufficient quantity of paint to facilitate proper and adequate analyses by testing laboratory.
4. Ensure that samples are adequately identified with location from which they were removed.

C. Laboratory testing of paint samples: In accordance with 40 CFR 261,
   1. Submit 10 copies of complete laboratory analyses of paint samples.

D. Submit a plan for the removal, containment, and disposal of lead-based paint and associated debris.
   1. Submit 10 copies of plan.

E. Prior to beginning work associated with the removal, containment, and disposal of lead-based paints, prepare and submit to the Engineer for his review 6 copies of the following:
   1. Listing of lead paint removal equipment to be used.
   2. Outline of procedures to be used to remove lead paint.
   3. Data and specifications describing chemical stripping materials to be used.
   4. Data and specifications describing abrasive blast materials and grit size to be used.
   5. Plan describing lead paint removal, hazardous waste debris containment, and hazardous waste disposal methods.
   6. Safety plan, consisting of a written plan of action covering operational requirements for safe removal of lead paint, safe handling and containment of waste and debris generated by the operation, and safe disposal of hazardous waste and non-hazardous waste materials, complying with the most stringent requirements of the following:
      a. Equipment and material manufacturer’s safety sheets.
      b. 29 CFR 1926.62.

F. Carry out lead paint removal, containment, and disposal work in accordance with the following SSPC guidelines:
   1. SSPC-Guide 6.
      a. Open Abrasive Blast Cleaning with Expendable Abrasive.
      b. Open Abrasive Blast Cleaning with Recyclable Abrasive.
      c. Closed Abrasive Blast Cleaning with Recyclable Abrasive.
      d. Chemical Stripping.
   2. SSPC-Guide 7.

G. Assume responsibility for the proper utilization of the paint removal method selected.
   1. When abrasive blast cleaning is selected to remove lead-based paint, comply with all applicable federal, state, and local air quality, pollution, and environmental control regulations for blast cleaning.
   2. When chemical stripping is selected to remove the lead based paint, adhere to the chemical manufacturer’s recommendations for the application of the product, the removal of the paint, and the containment of the debris.

H. Lead paint removal work shall be performed by a Contractor having prior experience in the removal method selected and shall provide at least 5 references of similar projects completed, 3 of which must have been completed within the past 12 months, documenting his experience.

I. Utilize a minimum of Class 3 containment and ventilation system as described in SSPC-Guide 6 during lead paint removal and containment procedures as required for the conditions.

J. Do not leave spent abrasive blast material, chemical stripping material, or lead paint debris uncontained on the project site overnight.

K. Test each container of paint debris, spent blast cleaning abrasive, chemical stripping debris, and other waste material generated by the operation to determine the waste material hazardous waste classification.

L. Assume responsibility for the disposal of lead paint waste and associated waste generated by the removal of the lead paint and the preparation of the surfaces for recoating. Dispose in accordance with applicable federal, state, and local requirements and regulations.

M. Accurately complete the Uniform Hazardous Waste Manifest included at the end of SSPC-Guide 7. Indicate on the Manifest that the Owner is the hazardous waste generator, and obtain the Owner's Environmental Protection Agency identification number for use in completing the Manifest.

1.07 ASBESTOS MATERIALS

A. It is the specific intent of these Contract Documents to exclude from the Work any and all products or materials containing asbestos. No products containing asbestos shall be incorporated in the Work.

B. Removal of existing ACM shall be performed by a firm that is registered by OSHA and certified by the State Contractors Licensing Board and shall be a licensed abatement contractor in the state where the Project is located.

C. Submit 10 copies of plan for the removal, containment, and disposal of ACM.

D. Submit 6 copies of abatement license of ACM removal contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 ASBESTOS MATERIALS

A. Notifications:
   1. Notify OSHA 24 hours prior to performing asbestos material removal operations.
   2. Notify Owner 3 working days in advance of commencing asbestos material removal operations.

B. Work area:
   1. Establish a regulated work area, using at a minimum, construction warning tape to establish limits of work area for the asbestos material removal.
   2. On site stockpiling or storage of asbestos material designated for disposal shall not be allowed.

C. Safety:
   1. Conduct an Initial Exposure Assessment (IEA).
   2. Provide a hand/face wash station.

D. Worker qualifications:
   1. Asbestos removal shall be performed by employees trained in wet methods, vacuum cleaners with HEPA filters to collect debris and prompt cleanup.

E. Legal disposal:
   1. Legal disposal of asbestos material is the Owner's responsibility.
   2. Transport the asbestos material to the location designated by the Owner and place into the location designated for this project.

3.02 EXCAVATION OF AC PIPE

A. Machine excavates to expose asbestos cement pipe.

B. Hand excavates areas under pipe where breaks are planned.

C. Pipe shall be pre-wetted prior to any breaks being made.

D. Pipe shall be snapped using mechanical snapping methods.

3.03 AC PIPE REMOVAL

A. All required pipe breaking operations shall require adequate pre-wetting with potable water.

B. Make every effort to minimize the number of pipe breaks. Wherever possible, the pipe should be removed by pulling the pipe out of the pipe joint collars.

C. Remove sections of AC pipe intact at joint collars by mechanical snapping methods between collars.

D. Wet and containerize waste materials as removed from the trench. Use lifting straps and methods that do not further damage the pipe.

E. Sections of AC pipe that become cut, have broken edges or have any friable surface shall be wet at exposed fractures and immediately wrapped.
   1. Pipe ends shall be sealed completely using a minimum 6-mil poly film wrap, which is securely fastened, taped to completely enclose the pipe and ACP appurtenances and shall have conspicuous, legible labeling that has the following or equivalent labeling: CAUTION: CONTAINS ASBESTOS FIBERS. BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM.

F. AC pipe sections shall not be left exposed in public view, either in trench or in disposal area.

G. All connecting parts of pipe, rubber gaskets, and pipe couplings shall be discarded with pipe.

H. AC pipe from this project only shall be placed in the bin designated.

END OF SECTION

SECTION 01_35_73

DELEGATED DESIGN PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Delegated Design procedures.

1.02 GENERAL

A. Delegated Design - Professional design services assigned to the Contractor by express delegation in the Contract Documents. Work is “Delegated Design” where the Technical Sections require the Contractor to provide professional design services and to submit signed and sealed documents from a registered Professional Engineer.

B. Contractor’s Professional Engineer - The design professional retained by the Contractor to perform Delegated Design.

C. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents.
   1. Requirements of Delegated Design component as specified in the Technical Section and as indicated on the Drawings.
   2. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that the Contractor must furnish to the Engineer with respect to the Delegated Design.

D. Contractor shall cause such Delegated Design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal shall appear on Drawings, calculations, Specifications, certifications, and Submittals prepared by such design professional.
   1. Contractor shall not be responsible for the adequacy of performance or design criteria specified by the Owner or Engineer.
   2. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.
   3. Such design professional shall issue certifications of design required by Laws and Regulations.
   4. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by the Contractor, a Subcontractor, or others for submittal to the Engineer, then such Shop Drawing or other Submittal shall bear the written approval of Contractor’s design professional when submitted by the Contractor to the Engineer.

E. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under Delegated Design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

F. Engineer's review, approval, and other determinations regarding design drawings, calculations, Specifications, certifications, and other Submittals furnished by Contractor pursuant to a Delegated Design will be only for the following limited purposes:
   1. Confirming that Submittal is in conformance with the performance and design criteria specified in the Contract Documents.

1.03 CONTRACTOR'S PROFESSIONAL ENGINEER

A. Contractor or Subcontractor shall retain a licensed Professional Engineer to perform Delegated Design.

B. Qualifications:
   1. Holding a current license to perform the specified design in the same jurisdiction as the Project Site unless otherwise noted in the associated technical section.
   2. Experienced in designing similar systems of similar complexity.

C. Insurance:
   1. Provide Contractor's Professional Engineer's Professional Liability Insurance as specified in Section 00_73_00 - Supplementary Conditions.

D. Responsibilities:
   1. Review and design in accordance with system performance and design criteria stated in the Contract Documents.
      a. Prepare written requests for clarifications or interpretations of performance or design criteria for submittal to the Engineer by the Contractor.
   2. Sign and seal design reports, calculations, design drawings and specifications, and other design Submittals for the Delegated Design Work.
   3. Review and submit written approval of Submittals related to the Delegated Design Work.
   4. Design modifications to the Delegated Design Work as required.
   5. Visit the Site, as required, to verify that installation of the Delegated Design Work is in conformance with the Delegated Design Drawings and Specifications.
   6. Submit through Contractor to Engineer written, signed, and sealed certification that the installed Delegated Design Work complies with Contractor's Professional Engineer's design.

1.04 SUBMITTALS

A. Prior to the start of Delegated Design:
   1. Contractor's Professional Engineer's qualifications:
      a. Experience for the Delegated Design.
      b. Evidence of Professional Engineering license.
   2. Contractor's Professional Engineer Professional Liability Insurance certificate.

B. Delegated Design:
   1. Product data:
      a. Details related to the Delegated Design as specified in Technical Sections to completely describe the system.
   2. Design documents with signature and seal from the Contractor's Professional Engineer.
      a. Design documents include, but are not limited to, Drawings, calculations, Specifications, inspection reports, and certifications.
   3. Lists and schedules:
      a. Prepare and submit lists or schedules of items where Delegated Design is required by the Contract Documents.
      b. Group items by location in the Work.
         1) When "Area Numbers" are indicated on the Contract Drawings, group lists in accordance with those "areas."
         2) For work without area numbers, group using logical divisions acceptable to the Engineer.
         3) Group items within each "area" as follows:
            a) Systems.
            b) Components.
            c) Supports.
            d) Anchorage.
            e) Bracing.

C. Construction services:
   1. Contractor's Professional Engineer's comments on Submittals.
   2. Other construction documents, as required.

1.05 ENGINEER RESPONSE TO DELEGATED DESIGN SUBMITTALS

A. Engineer response will be either of the following:
   1. Approved. Make Corrections Noted - See Comments:
      a. Contractor may proceed with the Work; however, all notations and comments must be incorporated into the final product.
      b. Review was for the limited purpose of determining that the document was stamped by a Professional Engineer and that such design is generally consistent with and will not negatively affect the design concept presented in the Contract Documents.
   2. Rejected - See Remarks:
      a. Contractor may not proceed with the Work described in the Submittal.
      b. Submittal does not meet the intent of the Contract Documents.
      c. Resubmittal of complete Submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_41_00

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Regulatory authorities and codes.

1.02 AUTHORITIES HAVING JURISDICTION (AHJ)

A. Also referred to as the permitting agency.

B. Building Department: City of Bellingham Permit Center.

C. Fire Department: City of Bellingham Fire Department.

1.03 APPLICABLE CODES

A. International Code Council (ICC).
   1. Building code:
      a. International Building Code (IBC), 2021.
         1) Local amendments.
      b. International Existing Building Code (IEBC), 2021.
         1) Local amendments.
   2. Electrical code:
      a. National Fire Protection Association (NFPA), NFPA 70: National Electrical Code (NEC), 2020.
         1) Local amendments.
   3. Energy code:
      a. International Energy Conservation Code (IECC), 2021.
         1) Local amendments.
   4. Fire code:
      a. International Fire Code (IFC), 2021.
         1) Local amendments.
   5. Fuel gas code:
      a. International Fuel Gas Code (IFGC) – 2021.
         1) Local amendments.
   6. Mechanical code:
      a. International Mechanical Code (IMC), 2021.
         1) Local amendments.
   7. Plumbing code:
      a. International Plumbing Code (IPC), 2021.
         1) Local amendments.

B. Washington State Building Codes Council (SBCC), Washington Administrative Code (WAC), Title 51 – Department of Commerce, Building Code Council:
   1. Building code:
      a. International Building Code (IBC), 2021.
      b. Washington State Amendments to the 2021 IBC (Chapter 51-50 WAC).
   2. Electrical code:
      a. National Fire Protection Association (NFPA), NFPA 70: National Electrical Code (NEC), 2021.
   3. Energy code:
      a. International Energy Conservation Code (IECC), 2021.
      b. Washington State Amendments to the 2021 IECC (Chapter 51-11C WAC).
      c. Washington State Energy Code, Commercial Provisions.
   4. Fire code:
      a. International Fire Code (IFC), 2021.
      b. Washington State Amendments to the 2021 IMC (Chapter 51-54A WAC).
   5. Mechanical code:
      a. International Mechanical Code (IMC), 2021.
      b. Washington State Amendments to the 2021 IMC (Chapter 51-52 WAC).
   6. Plumbing codes:
      a. Uniform Plumbing Code (UPC), 2021.
      b. Washington State Amendments to the 2021 UPC (Chapter 51-56 WAC).

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_45_00

QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Quality control and control of installation.
   2. Tolerances.
   3. References.
   4. Mock-up requirements.
   5. Authority and duties of Owner's representative or inspector.
   6. Sampling and testing.
   7. Testing and inspection services.
   8. Contractor's responsibilities.

1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

H. When specified, products will be tested and inspected either at point of origin or at Work site:
   1. Notify Engineer in writing well in advance of when products will be ready for testing and inspection at point of origin.
   2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.

I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.04 REFERENCES

A. ASTM International (ASTM):
   1. E329 - Standard for Agencies Engaged in Construction Inspection, Testing or Special Inspection.

B. National Institute of Standards and Technology (NIST).

1.05 PRODUCT REQUIREMENTS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.06 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups shall be comparison standard for remaining Work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.07 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

A. Owner’s Project Representative employed or retained by Owner is authorized to inspect the Work.

B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.

C. Deficiencies or defects in the Work which have been observed will be called to Contractor's attention.

D. Inspector will not:
   1. Alter or waive provisions of Contract Documents.
   2. Inspect Contractor's means, methods, techniques, sequences, or procedures for construction.
   3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor. Supervise, control, or direct Contractor's safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor's employees or others.

E. Inspector will:
   1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
   2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

1.08 SAMPLING AND TESTING

A. General:
   1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
   2. When specified in sections where products are specified:
      a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
      b. Test materials in accordance with standards of national technical organizations.

B. Sampling:
   1. Furnish specimens of materials when requested.
   2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
   3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
   4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.

1.09 TESTING AND INSPECTION SERVICES

A. Contractor will employ and pay for specified services of an independent firm to perform Contractor quality control testing as required in the technical specifications for various work and materials.

B. Owner will employ and pay for specified services of an “Owner’s independent testing firm” certified to perform testing and inspection as required in the technical specifications for various work and materials or stipulated in Section 01_45_24 - Regulatory Quality Assurance to confirm Contractor’s compliance with Contract Documents.

C. The Owner’s independent testing firm will perform tests, inspections and other services specified in individual specification sections and as required by Owner and requested by the Engineer.

D. The qualifications of laboratory that will perform the testing, contracted by the Owner or by the Contractor, shall be as follows:
   1. Has authorization to operate in the state where the project is located.
   2. Meets “Recommended Requirements for Independent Laboratory Qualification,” published by American Council of Independent Laboratories.
   3. Meets requirements of ASTM E329.
   4. Laboratory Staff: Maintain full time specialist on staff to review services.
   5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to NIST or accepted values of natural physical constants.
   6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NIST during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.

E. Testing, inspections, and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.

F. Contractor shall cooperate with Owner’s independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Notify Engineer and Owner’s independent testing firm 48 hours prior to expected time for operations requiring testing.
   2. Make arrangements with Owner’s independent testing firm and pay for additional samples and tests required for Contractor’s use.

G. Limitations of authority of testing Laboratory: Owner’s independent testing firm or Laboratory is not authorized to:
   1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency or laboratory may not approve or accept any portion of the Work.
   3. Agency or laboratory may not assume duties of Contractor.
   4. Agency or laboratory has no authority to stop the Work.

H. Testing and employment of an Owner’s independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

I. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Owner's independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

J. The Owner's independent testing firm responsibilities will include:
   1. Test samples of mixes submitted by Contractor.
   2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
   3. Perform specified sampling and testing of products in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
   6. Perform additional tests required by Engineer.
   7. Attend preconstruction meetings and progress meetings when requested.

K. Owner's independent testing firm individual test reports:
   1. After each test, Owner's independent testing firm will promptly submit electronically report to Engineer and to Contractor.
   2. Test reports shall include at least the following information:
      a. Date issued.
      b. Project title and number.
      c. Name of inspector.
      d. Date and time of sampling or inspection.
      e. Identification of product and specifications section.
      f. Location in Project.
      g. Type of inspection or test.
      h. Date of test.
      i. Certified test results stamped and signed by a registered Engineer in the state where the project is located.
      j. Summary of conformance with Contract Documents.
      k. When requested by Engineer, the Owner's independent testing firm will provide interpretation of test results.

1.10 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.

B. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

C. Provide to Owner's independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.

D. Submit product test reports electronically.

E. Furnish incidental labor and facilities:
   1. To provide access to construction to be tested.
   2. To obtain and handle samples at Work site or at source of product to be tested.
   3. To facilitate inspections and tests.
   4. For storage and curing of test samples.

F. Notify Owner's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_45_17

CONTRACTOR QUALITY CONTROL PLAN

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Contractor Quality Control Plan.

1.02 SUBMITTALS

A. Qualifications of the Contractor's Quality Control (CQC) Plan Manager.

B. Contractor's Daily Quality Control Report:
   1. Submit to Engineer within 1 day of completion of each inspection using the approved form.

C. Daily Inspection Report:
   1. Submit to Engineer at the end of each working day or no later than prior to the beginning of the next working day using the approved form.

1.03 CONTRACTOR'S INSPECTION OF THE WORK

A. Work performed by Contractor shall be inspected by the Contractor's CQC Plan Manager. Non-conforming Work and any safety hazards in the Work area shall be noted and promptly corrected.

B. No materials or equipment shall be used in Work without inspection and acceptance by Contractor's CQC Plan Manager.

1.04 QUALIFICATIONS

A. Contractor's CQC Plan Manager: Demonstrate having performed similar CQC functions on similar type projects. Submit records of personnel experience, training, and qualifying registrations.

B. Minimum qualifications: Candidate must have a minimum of 10 years of experience on projects of similar type and size.

1.05 COVERING WORK

A. Whenever Contractor intends to backfill, bury, cast in concrete, or otherwise cover any Work, notify Engineer not less than 24 hours in advance to request inspection before beginning any such Work of covering. Failure of Contractor to notify Engineer in accordance with this requirement shall be resolved according to Article 14 of the General Conditions.

1.06 CONTRACTOR'S QUALITY CONTROL PROGRAM

A. General: Establish and execute a Quality Control (CQC) Plan for Work. The plan shall establish adequate measures for verification and conformance to defined requirements by Contractor personnel and lower-tier Subcontractors (including Fabricators, Suppliers, and Subcontractors). This program shall be described in a Plan responsive to this Section.

B. CQC personnel:
   1. Contractor's CQC Plan Manager shall report to a Senior Project Manager of the Contractor and shall have no supervisory or managerial responsibility over the workforce.
   2. The Contractor CQC Plan Manager shall be on-site as often as necessary, but not less than the daily working hours specified in the Contract Documents to remedy and demonstrate that Work is being performed properly and to make multiple observations of Work in progress.
   3. The Contractor is to furnish personnel with assigned CQC functions reporting to the CQC Manager. Persons performing CQC functions shall have sufficient qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions.

C. CQC Plan:
   1. Contractor's CQC Plan shall include a statement by the Senior Project Manager designating the CQC Plan Manager and specifying the authority delegated to the CQC Plan Manager to direct cessation or removal and replacement of defective Work.
   2. Describe the CQC program and include procedures, work instructions, and records. Describe methods relating to areas that require special testing and procedures as required by the specifications.
   3. Include specific instructions defining procedures for observing Work in process and comparing this Work with the Contract requirements (organized by specifications section).
   4. Describe procedures to ensure that equipment or materials that have been accepted at the Site are properly stored, identified, installed and tested.
   5. Include procedures to verify that procured products and services conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to lower-tier Suppliers and/or Subcontractors.
   6. Commissioning quality control: Include procedures to verify that the commissioning requirements of the Contract Documents are integrated into the Contractor's CQC Plan and conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to the Contractor and the lower-tier Suppliers and/or Subcontractors.
   7. Include instructions for recording inspections and requirements for demonstrating through the Daily Inspection Reports that Work inspected was in compliance or a deficiency was noted and action to be taken.
   8. Procedures to preclude the covering of deficient or rejected Work.
   9. Procedures for halting or rejecting Work.
   10. Procedures for resolution of differences between the CQC Plan Manager and the production personnel.
   11. Identify contractual hold/inspection points as well as any Contractor-imposed hold/inspection points.

D. Daily Inspection Report: Include, at a minimum:
   1. Inspection of specific work.
   2. Quality characteristics in compliance.
   3. Quality characteristics not in compliance.
   4. Corrective/remedial actions taken.
   5. Statement of certification.
   6. CQC Manager's signature, electronic signature is acceptable.
   7. Information provided on the daily report shall not constitute notice of delay or any other notice required by the Contract Documents.

E. Deficient and Non-conforming Work and Corrective Action: Include procedures for handling deficiencies and non-conforming Work. Deficiencies and non-conforming Work are defined as documentation, drawings, material, equipment, or Work not conforming to the indicated requirements or procedures. The procedure shall prevent non-conformances by identification, documentation, evaluation, separation, disposition, and corrective action to prevent reoccurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documents and measures implemented to prevent recurrence. In addition, at a minimum, this procedure shall address:
   1. Personnel responsible for identifying deficient and non-complying items within Work.
   2. How and by whom deficient and non-compliant items are documented "in the field."
   3. The personnel and process utilized for logging deficient and non-compliant Work at the end of each day onto a deficiency log.
   4. Tracking processes and tracking documentation for deficient and non-conforming Work.
   5. Personnel responsible for achieving resolution of outstanding deficiencies.
   6. Include detailed procedures for the performance and control of special process (e.g., welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).

F. Audits: The CQC program shall provide for regularly scheduled documented audits to verify that CQC procedures are being fully implemented by Contractor and its Subcontractors. Audit records shall be made available to Engineer upon request.

G. Documented control/quality records:
   1. Establish methods for control of Contract Documents that describe how Drawings and Specifications are received and distributed to ensure the correct issue of the document being used. Describe how record document/drawing data are documented and furnished to Engineer.
   2. Maintain evidence of activities affecting quality. Including operating logs, records of inspection, audit reports, personnel qualification and certification records, procedures, and document review records.
   3. Maintain quality records in a manner that provides for timely retrieval and traceability. Protect quality records from deterioration, damage and destruction.
   4. Develop a list of specific records as required by the Contract Documents that will be furnished to Engineer at the completion of activities. This plan must specifically include operation and maintenance manuals.

H. Acceptance of CQC Plan: Engineer's acceptance of the CQC Plan shall not relieve Contractor from any of its obligations for performance of Work. Contractor's CQC staffing is subject to Engineer's review and continued acceptance. Owner, at its sole discretion, and without cause, may direct Contractor to remove and replace the CQC Plan Manager.
   1. Acceptance of the CQC Plan by the Engineer is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction.
   2. After acceptance of the CQC Plan, notify the Engineer in writing of any proposed change. Proposed changes are subject to acceptance by the Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_45_24

REGULATORY QUALITY ASSURANCE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Project regulatory requirements for quality assurance that includes Special Inspections, Special Certification, and Structural Observation.

B. Special Certification and Special Inspections in this Section are in addition to the requirements specified in Section 01_45_00 - Quality Control, and in the individual Sections.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete.

B. American Institute of Steel Construction (AISC):
   1. 360 - Specification for Structural Steel Buildings.

C. American Society of Civil Engineers (ASCE):
   1. 7 - Minimum Design Loads for Buildings and Other Structures.

D. American Welding Society (AWS):
   1. D1.3 - Structural Welding Code - Sheet Steel.
   2. D1.4 - Structural Welding Code - Reinforcing Steel.

E. ASTM International (ASTM):
   1. A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
   2. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   3. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
   4. C1611 - Standard Test Method for Slump Flow of Self-Consolidating Concrete.

F. Building Code:
   1. As specified in Section 01_41_00 - Regulatory Requirements.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Special Certification: Certification for designated seismic systems that demonstrates compliance with performance requirements.
   2. Special Inspection: Inspection of the materials, installation, fabrication, erection, or placement of components and connections requiring special

expertise to ensure compliance with approved construction documents and referenced standards.

3. Special Inspection, Continuous: The full-time observation of work requiring Special Inspection by an approved special inspector who is present in the area where the work is being performed.
4. Special Inspection, Periodic: The part-time, or intermittent observation of work requiring Special Inspection by an approved special inspector who is present in the area where the work is being performed and at the completion of the work.
5. Structural Observation: The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents at significant construction stages and at completion of the structural system.

1.04 SUBMITTALS

A. Submit Special Certifications for designated seismic systems.

B. Schedule and coordinate the submittal of Special Inspection reports and test results prepared by others.

1.05 SPECIAL INSPECTION

A. Owner will employ 1 or more special inspectors who will provide Special Inspections during construction.

B. Special inspector(s) shall be qualified for inspection of the particular type of materials or operations requiring Special Inspection.

C. Testing laboratory: Testing that is required to satisfy the requirements of Special Inspection will be performed by the Owner's testing laboratory as specified in Section 01_45_00 - Quality Control.

D. Duties of special inspector:
   1. General: Required duties of the special inspector(s) shall be as described in the Building Code.
   2. Reporting: Special inspector(s) shall provide reports of each inspection to the Owner and shall distribute copies of inspection reports to the Engineer and Contractor as required.
      a. Reports shall, at a minimum, include the following items:
         1) Date and time of inspection, and name(s) of individual(s) performing the inspection.
         2) Structures and areas of the structure where work or testing was observed.
         3) Discrepancies between the requirements of the Contract Documents and the work or testing observed.
         4) Other areas of deficiency in the Work.

E. Special Inspections shall not be construed as fulfilling the requirements for Structural Observation.

F. Owner or special inspector are responsible to select materials for Special Inspection.
   1. Contractor shall not select materials for Special Inspection.

1.06 SPECIAL CERTIFICATION

A. Provide equipment that meets the special certification requirements of the Building Code.

B. Designated seismic systems shall be subject to the testing and qualification requirements of the regulatory Building Code, and shall require Special Certification as set forth in ASCE 7:
   1. Mechanical equipment that is assigned an importance factor of 1.50 as specified in Section 01_81_50 - Design Criteria.
   2. All electrical equipment.

C. Special certification requirements for designated seismic systems:
   1. Submittals shall include certification that the equipment is seismically qualified. Certifications are subject to review and acceptance by Owner.
   2. Certifications may be at least one of the following in accordance with ASCE 7:
      a. Analysis.
      b. Testing.
      c. Experience data.

1.07 STRUCTURAL OBSERVATION

A. Owner will employ 1 or more registered design professionals to provide Structural Observation(s) during construction.
   1. Registered design professional will be a civil or structural engineer currently licensed as such in the state where the project is located and regularly engaged in structural design equivalent to or similar to that indicated on the Drawings.

B. Structural Observations shall not be construed as fulfilling the requirements for Special Inspections.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SPECIAL INSPECTIONS

A. Owner will provide Special Inspection of the following types of work as described in the Building Code wherever such work occurs, unless otherwise specified.
   1. Attachment A - Concrete - Special Inspection Schedule.
   2. Attachment B - Architectural, Mechanical, and Electrical Components - Special Inspection Schedule.

3. Attachment C - Soils - Special Inspection Schedule.
4. Attachment D - Structural Steel Welding - Special Inspection Schedule.
5. Attachment E - Structural Steel Bolting - Special Inspection Schedule.
6. Attachment F - Deep Foundations, Cast-in-Place - Special Inspection Schedule.

3.02 SPECIAL CERTIFICATION

A. Special inspector shall examine the designated seismic system(s) and determine whether the designated system components, including anchorage, are consistent with the evidence of compliance submitted for Special Certification.

3.03 STRUCTURAL OBSERVATION

A. The following work requires Structural Observation in accordance with the Building Code.
   1. All structures in all areas:
      a. Foundations.
         1) Mat foundation.
         2) Foundation pad and anchors.
      b. Walls.
         1) Concrete,
      c. Diaphragms.
         1) Elevated concrete slab.
      d. Structural connections that are part of the lateral load resisting system.
      e. Non-structural components.
         1) Support system for electrical, mechanical, and all other equipment and appurtenances.
   2. Frequency:
      a. Concrete construction:
         1) Once prior to placing concrete:
            a) Initial mat slab.
            b) Initial wall.
            c) Initial elevated slab and beam.
         2) After completion of reinforcing bar placement.
         3) Prior to concrete placement.
      b. Steel construction:
         1) Area 420: Precast concrete wall base connection to slab.
      c. Structural steel construction:
         1) Once at completion of steel installation.
      d. Non-structural components:
         1) Once near completion of construction.

3.04 SCHEDULE

A. Allow time necessary for Special Inspections and Structural Observation specified in this Section.

B. Sufficient notice shall be given so that the Special Inspections and Structural Observations can be performed. Allow time for individuals performing to travel to the site.

3.05 PROCEDURE

A. Special inspector will immediately notify the Engineer of any corrections required and follow notification with appropriate documentation.

B. Contractor shall not proceed until the work is satisfactory to the Engineer.

END OF SECTION

ATTACHMENT A - CONCRETE - SPECIAL INSPECTION SCHEDULE

CONCRETE - SPECIAL INSPECTION SCHEDULE
(Includes: Cast-in-place, precast, prestressed, precast-prestressed, and shotcrete.)

Verification and Inspection	Reference Standard	Frequency of Inspection(1) (During Task Listed)	
		Continuous	Periodic
1. Inspect reinforcement, including prestressing tendons, and verify placement.	ACI 318 Building Code		●
2. Reinforcing bar welding:			
a. Verify weldability of reinforcing bars other than ASTM A706;	AWS D1.4 ACI 318		●
b. Inspect single-pass fillet welds, maximum 5/16 inch; and	AWS D1.4 ACI 318		●
c. Inspect all other welds.	AWS D1.4 ACI 318	●	
3. Inspect anchors cast in concrete.	ACI 318		●
4. Inspect anchors post-installed in hardened concrete members:			
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads.	ACI 318	●	
b. Mechanical anchors and adhesive anchors not defined in 4.a.	ACI 318		●
5. Verify use of required design mix.	ACI 318 Building Code		●
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	ASTM C172 ASTM C31 ACI 318 Building Code	●	
7. Inspect concrete and shotcrete placement for proper application techniques.	ACI 318 Building Code	●	
8. Verify maintenance of specified curing temperature and techniques.	ACI 318 Building Code		●
9. Inspect prestressed concrete for:			
a. Application of prestressing forces; and	ACI 318	N/A	N/A
b. Grouting of bonded prestressing tendons.	ACI 318	N/A	N/A
10. Inspect erection of precast concrete members.	ACI 318	N/A	N/A
11. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	ACI 318	N/A	N/A
12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	ACI 318		●

Notes:
(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT B - ARCHITECTURAL, MECHANICAL, AND ELECTRICAL COMPONENTS - SPECIAL INSPECTION SCHEDULE

ARCHITECTURAL, MECHANICAL, AND ELECTRICAL COMPONENTS - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
1. Architectural components:			
a. Cladding - exterior, weighing more than 5 psf: Erection and fastening.	Building Code	N/A	N/A
b. Exterior insulation and finish system (EIFS):	Building Code	N/A	N/A
c. Non-bearing walls - exterior: Erection and fastening.	Building Code	N/A	N/A
d. Non-bearing walls - interior, weighing more than 15 psf.	Building Code		●
e. Veneer, exterior and interior, weighing more than 5 psf: Erection and fastening.	Building Code	N/A	N/A
f. Access floors: Erection and anchorage.	Building Code		●
g. Suspended ceiling system: Bracing.		N/A	N/A
h. Storage racks - 8 feet or greater in height: Anchorage.	Building Code		●
i. Skylight: Verification of safety compliance and labeling and installation.	Building Code	N/A	N/A
2. Plumbing, mechanical, and electrical components:			
a. Anchorage of other electrical and mechanical equipment over 400 lb. on floors or roofs.	Building Code		●
b. Installation and anchorage of pipelines carrying hazardous chemicals and their associated mechanical units.	Building Code		●
c. Installation and anchorage of pipelines greater than 8 inches in diameter.			●
d. Installation and anchorage of ductwork designed to carry hazardous materials.	Building Code		●
e. Installation and anchorage of ductwork greater than 6 sf in cross section.			●
f. Installation and anchorage of vibration isolation systems where Contract Documents require nominal clearance of 1/4 inch or less between the equipment support frame and its support/restraint.	Building Code	N/A	N/A

Verification and Inspection	Reference Standard	Frequency of Inspection(1) (During Task Listed)	
		Continuous	Periodic
g. Installation of mechanical and electrical equipment, including duct work, piping systems and their structural supports, where automatic fire sprinkler systems are installed.	Building Code	N/A	N/A
3. Fire-resistance elements:			
a. Sprayed fire-resistant coatings:	Building Code	N/A	N/A
b. Mastic and intumescent coatings:	Building Code	N/A	N/A
c. Fire-resistant penetrations and joint systems:	Building Code	N/A	N/A
4. Smoke control systems;	Building Code	N/A	N/A

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT C- SOILS - SPECIAL INSPECTION SCHEDULE

SOILS - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	Building Code		●
2. Verify excavations are extended to proper depth and have reached proper material.	Building Code		●
3. Perform classification and testing of fill and backfill materials.	Building Code		●
4. Verify use of proper materials, densities, and lift thicknesses during placement and compaction of fill and backfill.	Building Code	●	
5. Prior to placement of fill, observe subgrade and verify that site has been prepared properly.	Building Code		●

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT D - STRUCTURAL STEEL WELDING - SPECIAL INSPECTION SCHEDULE

STRUCTURAL STEEL WELDING - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
Inspection Tasks Prior to Welding	AISC 360		
1. Welding procedure specifications (WPSs) available.		●	
2. Manufacturer certifications for welding consumables available.		●	
3. Material identification (type/grade).			●
4. Welder identification system.			●
5. Fit-up groove welds (including joint geometry): • Joint preparation. • Dimensions (alignment, root opening, root face, bevel). • Cleanliness (condition of steel surfaces). • Tacking (tack weld quality and location). • Backing type and fit (if applicable).			●
6. Configuration and finish of access holes.			●
7. Fit-up of fillet welds: • Dimensions (alignment, gaps at root). • Cleanliness (condition of steel surfaces). • Tacking (tack weld quality and location).			●
8. Check welding equipment.			●
Inspection Tasks During Welding	AISC 360		
9. Use of qualified welders.			●
10. Control and handling of welding consumables: • Packaging. • Exposure control.			●
11. No welding over cracked tack welds.			●
12. Environmental conditions: • Wind speed within limits. • Precipitation and temperature.			●
13. WPS followed: • Settings on welding equipment. • Travel speed. • Selected welding materials. • Shielding gas type/flow rate. • Preheat applied. • Interpass temperature maintained (min/max). • Proper position (F, V, H, OH).			●

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
14. Welding techniques: • Interpass and final cleaning. • Each pass within profile limitations. • Each pass meets quality requirements.			●
Inspection Tasks After Welding	AISC 360		
15. Welds cleaned.			●
16. Size, length, and location of welds.		●	
17. Welds meet visual acceptance criteria: • Crack prohibition. • Weld/base-metal fusion. • Crater cross section. • Weld profiles. • Weld size. • Undercut. • Porosity.		●	
18. Arc strikes.		●	
19. k-area.		●	
20. Backing removed and weld tabs removed (if required).		●	
21. Repair activities.		●	
22. Document acceptance or rejection of welded joint or member.		●	
Notes: (1) "●" represents a required inspection activity for the project where it occurs.			

ATTACHMENT E - STRUCTURAL STEEL BOLTING - SPECIAL INSPECTION SCHEDULE

STRUCTURAL STEEL BOLTING - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
Inspection Tasks Prior to Bolting	AISC 360		
1. Manufacturer's certifications available for fastener materials.		●	
2. Fasteners marked in accordance with ASTM requirements.			●
3. Proper fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane).			●
4. Proper bolting procedure selected for joint detail.			●
5. Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements.			●
6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used.			●
7. Proper storage provided for bolts, nuts, washers and other fastener components.			●
Inspection Tasks During Bolting	AISC 360		
8. Fastener assemblies, of suitable condition, placed in all holes and washers (if required) are positioned as required.			●
9. Joint brought to the snug-tight condition prior to the pretensioning operation.			●
10. Fastener component not turned by the wrench prevented from rotating.			●
11. Fasteners are pretensioned in accordance with the RCSC Specification, progressing systematically from the most rigid point toward the free edges.			●
Inspection Tasks After Bolting	AISC 360		
12. Document acceptance or rejection of bolted connections.		●	

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT F - DEEP FOUNDATIONS, CAST-IN-PLACE - SPECIAL INSPECTION SCHEDULE

DEEP FOUNDATIONS, CAST-IN-PLACE - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
1. Observe drilling operations and maintain complete and accurate records for each element.	Building Code	●	
2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock or specified stratum (if applicable), and adequate end-bearing strata capacity. Record concrete or grout volumes.	Building Code	●	
3. For concrete or grout installations, perform additional Special Inspection in accordance with Attachment A - Concrete Special Inspection.	Building Code	-	-

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

SECTION 01_50_00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.

1.02 REFERENCE

A. American National Standards Institute (ANSI).

B. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

1.04 TEMPORARY UTILITIES

A. Temporary work must meet Specification Section 01_14_00 - Work Restrictions, specifically but not exclusively the Heron Colony restriction buffers, in both implementation and construction/assembly.

B. Temporary electrical power:
   1. Temporary electrical power is available at Building 320 Electrical Room existing 480-volt PP-32001 via existing Spare 15A-3P breaker (Circuits 8, 10, 12):
      a. The Contractor is responsible for providing breakers, switches, transformers, and cables required to obtain temporary power from this location.
      b. Provide a new larger circuit breaker in existing PP-32001 for temporary electrical power as required by Contractor's loads:
         1) Existing PP-32001 manufacturer: General Electric.
            a) Type: CCB
            b) 480-Volt, 3 phase, 3 wire, 60 Hz, Style 2. Factory Code T139.
            c) Suitable General Electrical Breakers TQD, TE, TF, TJ, TKM.
   2. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.

C. Temporary electrical lighting:
   1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.

2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
    a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by Contractor for lighting.

D. Temporary heating, cooling, and ventilating:
1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.

E. Temporary water:
1. Pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
2. Remove temporary piping and connections and restore affected portions of the facility to original condition before final acceptance.
3. Pay for water used for construction prior to final acceptance.
4. Development of potable water supply:
    a. Potable water is not available at construction site.
    b. Provide potable water for human consumption during construction period.
    c. Furnish potable water that meets requirements of Laws and Regulations.
5. Development of non-potable water supply:
    a. Post ample signs throughout the work area warning that plant water is not potable.
    b. Non-potable water is available from hydrants or hose valves within plant without cost. When combined demand of the Work and plant exceeds plant supply capacity, provide additional temporary supply capacity.

F. Temporary sanitary facilities:
1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
2. Existing facility use is not allowed.
3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

G. Temporary fire protection:
1. Provide fire protection required to protect the Work and ancillary facilities.

H. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

I. Utilities in existing facilities: As specified in Section 01_14_00 - Work Restrictions.

J. Temporary piping systems:
1. Submit layout drawings showing proposed routing of piping, including proposed pipe support and pipe restraint locations.
2. Submit product data for piping, fittings, appurtenances, restraints, supports, and other components of the temporary piping system.
3. Submit information at least 28 days prior to when each temporary piping system is scheduled to be installed and allow 14 days for review and comment.

1.05 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to ensure adequate load bearing capability:
   1. When requested, submit design calculations by professional registered engineer prior to application of loads.
   2. Submitted design calculations are for information and record purposes only.

D. Accident prevention:
   1. Exercise precautions throughout construction for protection of persons and property.
   2. Observe safety provisions of applicable Laws and Regulations.
   3. Guard machinery and equipment and eliminate other hazards.
   4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
   5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.

E. Barricades:
   1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
   2. Provide barriers with flashing lights after dark.
   3. Keep barriers in place until excavations are entirely backfilled and compacted.
   4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
   1. Provide devices in accordance with minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Hazards in public right-of-way:
   1. Comply with local jurisdiction standards and requirements for right-of-way barricades and other safety devices.
   2. Mark at reasonable intervals, trenches, and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
      a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
   3. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
      a. During hours of darkness, provide warning lights at close intervals.

H. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

I. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

J. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.

K. Fences:
   1. Enclose temporary offices and storage areas with fence adequate to protect temporary facilities against acts of theft, violence, and vandalism.
   2. When entire or part of site is to be permanently fenced, permanent fence may be built to serve for both permanent and temporary protection of the work site, provided that damaged or defaced fencing is replaced prior to Substantial Completion.
   3. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons.
      a. Bear responsibility for protection of plant and material on site of the Work when openings in existing fences are not closed.
   4. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.
   5. Fence temporary openings when openings are no longer necessary.

1.06 SECURITY

A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.07 ACCESS ROADS

A. General:
   1. Build and maintain access roads to and on site of the Work to provide for delivery of material and for access to existing and operating plant facilities on site.
   2. Build and maintain dust free roads which are suitable for travel at 20 miles per hour.

B. Off-site access roads:
   1. Build and maintain graded earth roads.
   2. Build roads only in public right-of-way or easements obtained by Owner.
   3. Obtain rights-of-way or easements when electing to build along other alignment.

C. On-site access roads:
   1. Maintain access roads to storage areas and other areas to which frequent access is required.

2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
4. Maintain on-site access roads free of mud.
5. Provide controls to prevent vehicles leaving the site from tracking mud off the site onto the public right-of-way.

1.08 TEMPORARY CONTROLS

A. Dust control:
   1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
   2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.

B. Noise control:
   1. Comply with noise and work hours regulations by local jurisdiction.
   2. In or near inhabited areas, particularly residential, perform operations in manner to minimize noise.
   3. In residential areas, take special measures to suppress noise during night hours.

C. Mud control:
   1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

1.09 PROJECT SIGN

A. Provide and maintain Project identification sign consisting of painted 8-foot wide by 4-foot high exterior grade plywood and minimum 10-foot long, 4 by 4 lumber posts, set in ground at least 3 feet, with exhibit lettering by professional sign painter using no more than 5 sign colors:
   1. List at least the title of the Project, and names of the Owner, Engineer, and Contractor.
   2. Identify Contractor's, Engineer's, names in upper right-hand corner underneath the bid number.

B. On third and fourth lines of printing, paint appropriate dollar amounts.

C. Erect Project identification sign where directed by Engineer within 14 days after the issuance of the Notice to Proceed.

D. Replace or repair the project sign if it is damaged or covered with graffiti within 2 working days of observation or notification of damage or graffiti.

1.10 CONTRACTOR FIELD OFFICES AND SHEDS

A. Maintain on Project Site weather tight space in which to keep copies of Contract Documents, progress schedule, shop drawings, and other relevant documents.

B. Provide field office with adequate space to examine documents and provide lighting and telephone service in that space.

C. Engineer field office:
   1. Not required.

1.11 FIELD OFFICE DATA SERVICE AND EQUIPMENT

A. Provide the following data services for the duration of the project.

B. Contractor is responsible for maintenance of service and hardware.

C. Data service
   1. Broadband Internet.
      a. Minimum Internet bandwidth speed:
         1) Download: 50 Million bits per second (Mbps).
         2) Upload: 10 Million bits per second (Mbps).
      b. Modem, if applicable: Disable the wireless radio.

D. Printer/Scanner:
   1. Manufacturers: The following or equal:
      a. Canon Color Digital Multifunction printer (ImageRUNNER Advance C3330i).
   2. Functions:
      a. Print, scan, and sort 11 inch by 17 inch and smaller paper size.
      b. Send and receive Fax.
   3. Maintenance contract: Onsite maintenance for duration of project.
   4. Supplies: Paper (8 1/2 inch by 11 inch, 8 1/2 inch by 14 inch, and 11 inch by 17 inch) trays, toner, and other supplies for duration of project.

1.12 REMOVAL

A. Remove temporary facilities and controls before inspection for final Completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.

D. Restore existing facilities used during construction to specified or original condition.

1.13 TEMPORARY PROCESS PIPING SYSTEMS

A. Provide piping, appurtenances, valves, and other materials as required to provide temporary piping systems as specified in this Section, as indicated on the Drawings, and as needed to perform the Work.

B. Provide field route piping as needed and as field conditions dictate, unless otherwise indicated on the Drawings, and determine appropriate lengths of piping and quantity/type of pipe fittings needed to construct temporary piping system. Do

not block access points such as stairs, doors, and walkways to existing facilities unless approved in writing by the Owner.

C. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
   1. When piping is buried, use concrete thrust block or mechanical restraints.
   2. When piping is exposed or under water, use mechanical or structural restraints.
   3. Determine thrust forces by multiplying the nominal cross sectional area of the piping by the operating pressure of the piping.

D. Install temporary piping systems in a manner that will not damage existing or new facilities.

E. Piping material, including gaskets: Suitable for the process fluid requiring temporary piping, unless indicated otherwise.

F. Temporary piping includes, but is not limited to, the following piping services:
   1. RAS Improvements:
      a. Discharge and conveyance piping for three existing RAS pumps from Area 340 Secondary Sludge Pump Station to Area 305 Selector/Activated Sludge Basin 1 as shown on Sheet 030C101 and described in Section 01_14_00 - Work Restrictions. Install temporary blind flange on existing 30-inch RAS pipe into basin and install interface connection as required to connect temporary piping to the existing 30-inch diameter piping discharging to Area 305 Selector/Activated Sludge Basin 1.
      b. Temporary RAS Piping Requirements:
         1) Temporary RAS discharge valves (check and isolation) immediately downstream of the existing RAS pump may be 12-inch diameter to match the pump discharge nozzle. A maximum length of 50 linear feet of temporary 12-inch (inside) minimum diameter piping is allowed from the pump discharge nozzle, after which piping shall increase in diameter as specified below.
         2) Piping downstream of the temporary RAS discharge valves for each individual pump run shall increase to minimum inside diameter of 16 inches and be constructed of fused HDPE (DR 26 minimum) the entire length to the connection point at Area 305 Selector/Activated Sludge Basin 1.
            a) If a common, larger diameter, pipe is used to convey temporary RAS flow for multiple pumps, Contractor shall submit head loss calculations demonstrating head losses are equivalent to or less than individual 16-inch diameter piping runs.
   2. As needed and determined by Contractor to maintain Thickened Sludge Pump service in Area 530 while Work is occurring in that area that affects pump operation.
   3. As needed and determined by Contractor to maintain polymer/sludge mixing in Area 530.

G. After temporary piping system is no longer required:
   1. Remove temporary piping system.
   2. Clean and repair damage caused by installation or use of temporary piping system.
   3. Restore existing facilities to original condition.

1.14 TEMPORARY EQUIPMENT

A. Install polymer/sludge mixer in Area 530 as required to meet the mixing restrictions outlined in Section 01_14_00 - Work Restrictions. Existing polymer/sludge mixer can be repurposed/relocated as needed to meet this temporary polymer/sludge mixer requirement.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_60_00

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for products.

1.02 TERMINOLOGY

A. The words and terms listed below, are not defined terms that require initial capital letters, but, when this Section is referenced in other Specifications, have the indicated meaning.
   1. Manufacturer's instructions:
      a. Stipulations, directions, and/or recommendations issued by the manufacturer of the product addressing handling, storage, installation, protection, erection, and/or application of the product.
   2. Product data:
      a. Information about the product, typically found in the manufacturer's catalogs specifications or other resources, including data sheets, bulletins, and brochures.
   3. Spare parts and maintenance products:
      a. Duplicate parts necessary to replace a damaged or worn part of the product.
      b. Consumables such as operating fluids.
   4. Special tools:
      a. Special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a product that would not normally be in the Owner's tool kit and that have been specifically made for use on a product for assembly, disassembly, repair, or maintenance.

1.03 SHIPMENT

A. Requirements prior to shipment of equipment:
   1. Engineer approved Submittals or other written documentation allowed by the Contract Documents.
   2. Engineer approved Manufacturer's Certificate of Source Testing.
   3. Operations and maintenance manuals as specified in Section 01_78_24 - Operation and Maintenance Manuals and the Technical Sections.

B. Transport products by methods that avoid product damage.

C. Deliver products in undamaged condition in the manufacturer's unopened packaging.

1.04 DELIVERY AND HANDLING

A. Handle products in accordance with the manufacturer's instructions.

B. Deliver products in undamaged condition in the manufacturer's unopened packaging.

C. Provide construction equipment and personnel to handle products by methods in accordance with the manufacturer's instructions.

D. Upon delivery, promptly inspect shipments:
   1. Verify compliance with the Contract Documents, correct quantities, and undamaged condition of products.
   2. Acceptance of shipment does not constitute final acceptance of products.

E. Owner may request advanced delivery of spare parts, maintenance products, and special tools.
   1. Deduct the delivered items from the inventory list and provide transmittal documentation.

1.05 STORAGE

A. Immediately store and protect products until installed in the Work.

B. Store products with seals and legible labels intact.

C. Protect painted or coated surfaces against impact, abrasion, discoloration, and damage.

D. Storage of equipment in accordance with the manufacturer's instructions.
   1. Including connection of motor heaters, lubrication, manually rotating shafts, etc.
   2. Furnish a copy of the manufacturer's instructions for storage to the Engineer prior to storage of equipment and materials.

E. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for mechanical equipment, valves, architectural items, electrical and instrumentation equipment.

F. Storage of spare parts, maintenance products, special tools.
   1. Immediately store in accordance with the manufacturer's instructions.
   2. Store spare parts, maintenance products, and special tools in an enclosed, weather-proof, and lighted facility during the construction period.
   3. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.
   4. Store large items individually:
      a. Weight: Greater than 50 pounds.
      b. Size: Greater than 24-inches wide by 18-inches high by 36-inches long.
      c. Clearly labeled:
         1) Equipment tag number.
         2) Equipment manufacturer.
         3) Subassembly component, if appropriate.

5. Store smaller items in spare parts boxes:
    a. Weight: Less than 50 pounds.
    b. Size: Less than 24-inches wide by 18-inches high by 36-inches long.
    c. Clearly labeled:
        1) Equipment tag number.
        2) Equipment manufacturer.
        3) Subassembly component, if appropriate.
6. Spare parts and special tools box:
    a. Box material: Waterproof, corrosion resistant.
    b. Hinged cover with locking hasp:
        1) Inventory list taped to underside of cover.
        2) Clearly labeled:
            a) “Spare Parts and/or Special Tools”.
            b) Equipment tag number.
            c) Equipment manufacturer.
            d) Subassembly component, if appropriate.

G. Exterior storage of fabricated products:
1. Place on aboveground supports that allow for drainage.
2. Cover products subject to deterioration with impervious sheet covering.
3. Provide ventilation to prevent condensation under covering.

H. Store moisture sensitive products in watertight enclosures.

I. Store loose granular materials on solid surfaces in well-drained area.
1. Prevent materials mixing with foreign matter.
2. Provide access for inspection.

J. Provide an equipment log and stored products log with monthly pay applications.
1. Include: Storage location, equipment or product identification, date stored, date of inspection/maintenance, date removed from storage, copy of manufacturer’s recommended storage guidelines, description of inspection/maintenance activities performed, and signature of party performing inspection/maintenance.

K. When needed and approved by the Engineer, offsite storage location shall be within 20 miles of the Project Site.
1. Provide proof of insurance coverage for products stored offsite.

L. Payment will not be made for products improperly stored or stored without providing the Engineer with the manufacturer’s instructions for storage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide products by the same manufacturer when units are of similar nature, unless otherwise specified.

B. Provide like parts of duplicate units that are interchangeable.

C. Provide equipment or products that have not been in service prior to delivery, except as required by tests.

D. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
   1. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

E. Provide products produced by manufacturers regularly engaged in the production of these products.

F. Provide products that bear approvals and labels as specified such as Factory Mutual (FM), Underwriters Laboratory (UL), or National Sanitation Foundation (NSF International) that are acceptable to the Authority Having Jurisdiction.

2.02 MATERIAL

A. Dissimilar metals:
   1. Separate contacting surfaces with dielectric material.
   2. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators, washers, petrolatum tape, or other materials as specified.
   3. Dielectric coatings can be used to separate dissimilar metal couples from surrounding environment if isolation of metals is not possible, with approval of the Engineer.

B. Edge grinding:
   1. Sharp projections of cut or sheared edges of ferrous metals which are not to be welded shall be ground to a radius required to ensure satisfactory paint adherence and mitigate any safety hazard.
   2. A surface profile will need to be re-established for coating adherence based on coating manufacturer’s profile requirements.

C. Use anti-galling compound on threads of stainless steel fasteners during factory assembly.

D. Provide anti-galling compound with stainless steel fasteners shipped for field assembly.

E. Aluminum in contact with concrete or masonry: Apply epoxy mastic as specified in Section 09_96_01 - High-Performance Coatings, coating system EPX-M-5.

2.03 PRODUCT SELECTION

A. When products are specified without named manufacturers, provide products that meet or exceed the Specifications.

B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide products by one of the named manufacturers that meet or exceed specifications.

C. When products are specified with names of manufacturers and model numbers or catalog designations, provide products with model numbers or catalog designations by one of the named manufacturers.

D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
   1. Products specified by brand or trade name, model number, or catalog designation.
   2. Products by another named manufacturer proven, in accordance with requirements for an “or equal”, including the Engineer’s approval, to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.

E. When products are specified with only one manufacturer followed by “or equal,” provide:
   1. Products meeting or exceeding specifications by specified manufacturer.
   2. Engineer deemed “or equal” evidenced by an approved Shop Drawing or other written communication.

F. When products are specified by naming 2 or more manufacturers with 1 manufacturer as a “Basis of Design”:
   1. Any of the named manufacturers can be submitted.
   2. If the product submitted is not by the named “Basis of Design” product and requires a change in the scope (dimensions, configuration, physical properties, etc.), schedule (longer lead time), or budget, the Contractor must submit a substitution request.

2.04 SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. Provide spare parts and maintenance products as required by Technical Sections.
   1. Submit completed Attachment A - Spare Parts, Maintenance Products, and Special Tools Inventory List.

B. Provide 1 set of special tools required to install or service the equipment.

C. Prior to Substantial Completion, arrange to deliver spare parts, maintenance products, and special tools to the Owner at a location on site, chosen by the Owner.
   1. Provide itemized list of spare parts and special tools that matches the identification tag attached to each item.
   2. Owner and Engineer will review the inventory and the itemized list to confirm it is complete and in good condition prior to signing for acceptance.

D. Contractor is responsible for spare parts, maintenance products, and special tools until acceptance by the Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Inspect equipment or products prior to installation.

B. Repaint or recoat damaged painted or coated surfaces after installation.

C. Use anti-galling compound on stainless steel threads used for field assembly.

3.02 PROTECTION AFTER INSTALLATION

A. Provide coverings as necessary to protect installed products from damage due to traffic and subsequent construction operations.
   1. Remove covering when no longer needed.
   2. Replace corroded, damaged, or deteriorated products before acceptance of the Project.

B. Update equipment log with monthly pay applications.
   1. Data includes as a minimum: Description of maintenance activities performed in accordance with the manufacturer's recommendation and industry standards and signature of party performing maintenance.

END OF SECTION

ATTACHMENT A - SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

Owner: _____ **Date:** _____

Contractor: _____ **Project No.:** _____

Project Name: _____

Inventory List				
Spec Number: 23_05_00		Spec Title COMMON WORK RESULTS FOR HVAC		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
2		Filters: 2 extra (3 total) sets per each unit with filters		
1		Sheaves and belts: 1 set for change-out for final balance per unit installed		
1		Belts: 1 extra set for each unit installed as determined by final balance		
1		Provide a 2-year supply of maintenance products as specified in the manufacturer's maintenance literature		

Inventory List				
Spec Number: 26_28_14		Spec Title LOW VOLTAGE FUSES		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
3		Provide 3 spare fuses for each size and type used or supplied under any Section		
	Metal cabinet with hinged door and shelves or fuse holders. Gray enamel finish. Mount near equipment and label "Spare Fuses" on face of cabinet. Suitable pocket inside door of each cabinet with typewritten spare fuse inventory in clear plastic protective insert. Provide as many cabinets as required to hold entire spare fuse inventory.	Provide spare fuse cabinet(s)		

Inventory List				
Spec Number: 26_29_05		Spec Title MOTOR STARTERS		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		One spare fuse of each size and type per starter		

Inventory List				
Spec Number: 26_29_24		Spec Title VARIABLE FREQUENCY DRIVES 0.50-50 HORSEPOWER		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		One set of power and control fuses for each VFD		
1		One complete main control keypad for each type and rated size of VFD		
1		One spare fan for each VFD unit		
2		Two sets of ventilation filters for each VFD unit (if applicable in VFD cabinet louvers)		
1		One set of thyristors or power electronics for each type and rated size of VFD		
1		Any special dedicated tools for emergency service and troubleshooting		
1		Hardware and software required for configuration, maintenance, troubleshooting, and inquiry of drive parameters		

Inventory List				
Spec Number: 26_50_10		Spec Title LIGHTING: LED LUMINAIRES		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		Furnish one complete spare LED luminaire, with driver, of each type used		

Inventory List				
Spec Number: **40_05_57.24**		Spec Title **ELECTRIC ACTUATORS**		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
		Stem nut		
		Worm Shaft subassembly		
		Drive sleeve subassembly		
		Complete actuator seal kit		
		Actuator gearbox oil (sufficient quantity to fill 4 gearboxes)		
		Encoder		
		Control module		
		Setting tool, if required for setting or configuring the actuator		

Inventory List				
Spec Number: 40_64_01		Spec Title	CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS	
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		CPU: 1 spare for each type of CPU in the system		
3		I/O cards: 3 spares for each type of I/O card in the system		
2		Power supplies: 2 spares for every power supply in the system		
1		Network/communication cards: 1 spare for every network or communications card in the system.		
1		Remote adapter: 1 spare for every remote adaptor in the system		
1		Chassis: 1 spare for each chassis size in the system		
1		Communication cable: 1 spare for each type of cable used in the system		
		I/O Points (installed spare requirements)		
		PLC backplane capacity (installed spare requirements)		
		PLC memory (installed spare requirements)		

Inventory List				
Spec Number: 40_73_63		Spec Title	PRESSURE/VACUUM MEASUREMENT: DIAPHRAGM AND ANNULAR SEALS	
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		Furnish a spare annular seal for every size provided in the project		

Inventory List				
Spec Number: 43_23_31.30		Spec Title VERTICAL NON-CLOG CENTRIFUGAL PUMPS		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		1 Set of special tools required for complete assembly or disassembly of the pump system components for each type or size of pump specified		
1		One pump thrust bearing set		
1		One pump radial bearing set		
		Motor bearing set of each type		
		Pump impeller, trimmed to match installed impeller		
1		One mechanical seal set		

Inventory List				
Spec Number: 43_23_58.13		Spec Title SINGLE-LOBE ROTARY PUMPS		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		1 spare rotor set or set of replaceable rotor tips (for each type or size of pump).		
1		1 set of mechanical seals (for each type or size of pump).		
1		1 set of O-rings (for each type or size of pump).		
1		1 set of wear plates (front, back, and radial for each type or size of pump).		
1		1 Set of special tools required for complete assembly or disassembly of the pump system components for each type or size of pump specified.		

Inventory List				
Spec Number: 43_25_00.10		Spec Title SUBMERSIBLE SUMP PUMPS		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		1 set of special tools for each type or size of pump		
1		Touch-up paint: 1 Pint of finish coating paint		
1		Mechanical seal set		

Inventory List				
Spec Number: 46_34_01		Spec Title INLINE DYNAMIC SLUDGE MIXER		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		1 Set of O-rings for each type and size required by the units		
1		1 Set of Bearings for each type and size required by the units		
1		1 Set of Mechanical seals for each type and size required by the units		
1		1 Set of Power cable grommet for each type and size required by the units		
1		1 Set of Epoxy coating repair kit for each type and size required by the units		

Inventory List				
Spec Number: 46_41_10		Spec Title SURFACE-MOUNTED MIXERS		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
1		One complete set of bearings for each motor, if applicable		
1		One set of rubber buffers per installed mixer type		
1		One shaft holder for each shaft diameter supplied		
		All lubricating oils required for first year of operation (The products supplied shall be factory prefilled)		
		Spare parts shall be identical to and interchangeable with similar parts installed		
		Tools required to assemble, dissemble, repair, and maintain equipment, and that have been specifically made for use on the equipment		
		Necessary eyebolts, hooks, and rods for handling equipment parts		
		List of tools with the maintenance and operation data describing the uses of the tools		

Inventory List				
Spec Number: 46_78_83		Spec Title PACKAGED BIOTRICKLING FILTER ODOR CONTROL SYSTEM		
Equipment Tag No.:		Equipment Manufacturer:		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**
2		2 sets of belts		
1		1 set of bearings		
1		2-year supply of grease		
		Supply spare parts and special tools		
1		1 complete set of manufacturer's recommended spare parts		

SECTION 01_71_23

FIELD ENGINEERING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Field engineering to establish lines and grades for the Work.

1.02 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Qualifications of the professional land surveyor or licensed civil engineer with the authority to provide land surveying in Washington that will be performing the field engineering.

C. Pre-Excavation Report.

1.03 PRE-EXCAVATION REPORT

A. Prior to the start of the Work, create a report confirming the verification of the following data:
   1. Site elevation.
   2. Existing structures, including, but not limited to, buildings, manholes (sanitary, storm, electrical, and other), drainage inlets:
      a. Location coordinates.
      b. Top of wall elevation and coordinates.
      c. Floor elevations.
      d. Invert elevations.
   3. Existing utilities as specified in Section 33_05_01 - Subsurface Utility Engineering.
   4. Proposed building corners, tank, and equipment locations.
   5. Verify existing electrical, instrumentation, and phone utilities.

B. Incorporate information from Pre-Excavation Report into the Record Drawings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SURVEY REFERENCE POINTS

A. Basic reference line, a beginning point on basic reference line, points with referenced coordinates, and a benchmark will be provided by the Owner.

B. From these reference points, establish other control and reference points as required to properly lay out the Work.

C. Locate and protect control points prior to starting site work, and preserve permanent reference points during construction:
   1. Make no changes or relocations without prior written notice.
   2. Replace Project control point, when lost or destroyed, in accordance with original survey control.

D. Set monuments for principal control points and protect them from being disturbed and displaced:
   1. Re-establish disturbed monuments.
   2. When disturbed, postpone parts of the Work that are governed by disturbed monuments until such monuments are re-established.

3.02 PROJECT SITE SURVEY REQUIREMENTS

A. Establish minimum of 2 permanent benchmarks on site referenced to data established by survey control points.

B. Record permanent benchmark locations with horizontal and vertical data on Project Record Documents.

C. Perform verifications and checking in accordance with industry standard surveying practice.

D. Maintain complete, accurate log of control points and survey.

E. Affix civil engineer's or professional land surveyor's signature and license number to Record Drawings to certify accuracy of information shown.

3.03 CONSTRUCTION STAKES, LINES, AND GRADES

A. Execute the Work in accordance with the lines and grades indicated.

B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

3.04 QUALITY CONTROL

A. Accuracy of stakes, alignments, and grades may be checked randomly by the Engineer:
   1. Notice of when checking will be conducted will be given.
   2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
   3. Engineer's check does not substitute or complement required field quality control procedures.

3.05 RECORD DOCUMENTS

A. Prepare and submit Record Documents as specified in Section 01_77_00 - Closeout Procedures.

END OF SECTION

SECTION 01_75_17

COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Commissioning.

1.02 DEFINITIONS

A. Commissioning: The process of planning for, testing of, and start-up of systems, subsystems, equipment, components, and devices of the Work to demonstrate, through documented verification, that the Work has successfully met the Contract Documents. It includes training the Owner's staff on operation and maintenance of the installed Work.

B. Commissioning Phases: The activities of commissioning are grouped into the phases defined in the following table.
   1. Table 1 - Commissioning Phases.

TABLE 1 - COMMISSIONING PHASES		
Planning Phase	**Testing and Training Phase**	**Start-Up Phase**
Draft Test Plans	Source Testing: • Documentation	Start-Up: • Documentation • Owner Training
	Installation Verification: • Documentation • Owner Training	
	Functional Testing: • Documentation • Owner Training	

   2. Attachment A provides Commissioning Flowcharts.

C. Component: A part of a system that does not have an electrical connection or internal electronics. Examples: Piping and pressure gauges.

D. Device: A part of a system that has electrical connections or internal electronics. Examples: Level transmitter or pressure transmitter.

E. Electrical Energization Plan: A plan to manage how and when power is applied to electrical equipment.

F. Equipment: A factory or field assembled apparatus that performs an identifiable function. Examples: Pumps, motors, VFDs, MCCs.

G. Functional Testing: Testing performed on a completed subsystem or system to demonstrate that the system meets the specified requirements. Example systems: Backwash system, dewatering system.

H. Installation Verification: Testing to demonstrate that equipment or system and associated components or devices have been properly installed. Example equipment: Pumps, meters, and blowers with associated piping.

I. Manufacturer's Certificate of Functional Compliance: The form completed by the manufacturer to confirm that testing of the installed equipment or system has been performed and the results conform to the specified performance. The form is provided in Attachment D provided at the end of this Section.

J. Manufacturer's Certificate of Installation Verification: The form completed by the manufacturer to confirm that the equipment or system is installed in conformance with the Contract. The form is provided in Attachment C at the end of this Section.

K. Manufacturer's Certificate of Source Testing: The form completed by the manufacturer to confirm that the specified source tests have been performed and the results conform to the specified requirements. The form is provided in Attachment B at the end of this Section.

L. Owner Training: The Owner's staff is trained by the Contractor, with assistance from manufacturer, to operate and maintain the completed Work. This is sometimes referred to as Vendor Specific Training.

M. Process Stream: A series of liquid or solids flow processes that are designed to improve the water quality to meet regulatory permit requirements.

N. Source Testing: Test equipment or products for performance at point of manufacture or assembly for the requirements specified in the Contract Documents. Also referred to as factory testing and factory acceptance testing (FAT).

O. Start-Up: Operating the Work with process water to verify the Work meets the Contract Documents.

P. Start-Up Phase: The phase when Start-Up occurs.

Q. Subsystem: A grouping of equipment, components, and devices that is a part of a larger system and that perform a single definable function. Examples: Sand filters, filter backwash.

R. System: A grouping of equipment, components, and devices that perform a single definable function. If a system is a part of a larger system, it is referred to as a subsystem.
   1. Examples: Flocculation and sedimentation, filtration.

S. System Testing: Testing of a completed system for an extended time period. Examples: Headworks, filtration.

T. Water Management Plan: A plan to manage the test water used for commissioning from source to disposal. The test water may be clean water, potable water, non-

potable water, or process water (e.g., raw water, plant water, sludge). The plan demonstrates how water will be produced, conveyed, treated, disposed of as directed by the plant manager, and/or recycled.

1.03 SUBMITTALS

A. Project Commissioning:
   1. Commissioning Coordinator's qualifications.
      a. Submit to Engineer no later than 30 days after Notice to Proceed.
      b. Describe previous similar experience on similar projects with a list of references, including phone numbers.
      c. Provide names and qualifications of commissioning assistants, if applicable.
   2. Schedules:
      a. Commissioning Schedule containing all commissioning activities.
      b. Owner Training Schedule.
   3. Test Plans:
      a. Submit draft Test Plan outlined in the Planning Phase, unless specified otherwise.
         1) Engineer approval of draft Test Plans required for successful completion of Planning Phase.
      b. Submit final Test Plan a minimum of 45 calendar days prior to testing.
      c. Engineer approval of final Test Plan required prior to start of testing.
   4. Test Reports:
      a. Submit draft Test Reports outline in the Planning Phase, unless specified otherwise.
         1) Engineer approval of draft Test Reports outline required for successful completion of Planning Phase.
      b. Submit final Test Report a maximum of 30 calendar days after testing.

B. Technical Sections Commissioning:
   1. Manufacturer's representative's qualifications.
      a. Submit to Engineer no later than 30 days in advance of required services.
      b. Representative's name, phone, and e-mail address:
         1) May use 2 representatives: 1 for field testing and 1 for Owner Training.
         2) Provide resume stating instructor's technical expertise and instructional technology skills and experience.
   2. Test Plans:
      a. Submit draft Test Plan outlined in the Planning Phase, unless specified otherwise.
         1) Engineer approval of draft Test Plans required for successful completion of Planning Phase.
      b. Submit final Test Plan a minimum of 45 calendar days prior to testing.
      c. Engineer approval of final Test Plan required prior to start of testing.
   3. Test Reports:
      a. Submit draft Test Reports outline in the Planning Phase, unless specified otherwise.
         1) Engineer approval of draft Test Reports outline required for successful completion of Planning Phase.
      b. Submit final Test Report a maximum of 30 calendar days after testing.
   4. Manufacturer's representatives field notes and data.

5. Owner Training:
    a. Prior to the training session:
        1) Training instructor qualifications.
        2) Training course materials: Due 30 calendar days prior to initial training session.
            a) If Owner requires, Continuing Education Units (CEUs), submit training materials to state regulatory agency in sufficient time to obtain approval for training prior to the training.
            b) Drafts of training agenda, lesson plan, presentation, handouts, and list of audio-visual aids.
            c) Format: 1 electronic copy in the format and 3 hard copies organized in notebooks.
    b. Post training session:
        1) Training course materials: Due 14 calendar days after class completion.
            a) Recordings.
            b) Class attendance sheet.
            c) Final version of training agenda, final lesson plan, presentation, handouts, and audio-visual aids.
            d) Format: 1 electronic copy in the format and 3 hard copies organized in notebooks.
        2) Provide materials for all sessions of the class in a single transmittal.
        3) If the Owner requires training CEUs, issue training CEU certificates approved by the state regulatory agency to Owner's staff who successfully completed the training.

1.04 COMMISSIONING COORDINATOR (CC)

A. Responsibilities include the following:
    1. Part-time person.
    2. Become thoroughly familiar with Contract Commissioning requirements.
    3. Provide the primary interface with Engineer and Owner for Commissioning efforts.
    4. Lead Commissioning efforts - all phases and tasks.
    5. Coordinate training efforts.
    6. Meetings:
        a. CC is responsible for setting Commissioning coordination meeting dates and times, as well as preparing the agendas and meeting minutes.
        b. CC shall conduct Commissioning progress meetings throughout construction, to plan, scope, coordinate, and schedule future activities, resolve problems, etc.
        c. Frequency: Monthly minimum. Increase frequency as needed based on complexity and quantity of Commissioning activities.

B. CC on site:
    1. Testing and Training Phase: Full-time during days where equipment is being tested and training is provided.
    2. Start-Up Phase: Full-time during days where equipment is being started up.

1.05 MANUFACTURER'S REPRESENTATIVES

A. Qualifications: As specified below and in the Technical Sections:
   1. For Installation and Functional Testing:
      a. Factory trained and experienced in the technical applications, installation, operation, and maintenance of respective equipment/system with full authority by the equipment/system manufacturer to issue the certifications required of the manufacturer.
   2. Training instructor qualifications:
      a. Provide resume stating instructor's technical preparation and instructional technology skills and experience.
      b. If CEUs are required, the operator training instructors must comply with state regulatory.
      c. Knowledgeable in the equipment/system for which they are training.
      d. Experienced in conducting classes.
      e. Sales representatives are not qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.
   3. Representatives to be approved by Owner and Engineer.
   4. No substitute representatives without written approval by Owner and Engineer.

B. Duties:
   1. Determine if additional time and/or trips (beyond those specified in the Technical Sections) is required to perform the specified services.
   2. Coordinate services in accordance with the Contractor's Project schedule, up to and including making multiple trips to the Project Site when there are separate milestones associated with installation of each occurrence of manufacturer's equipment.
   3. Perform on-site services as specified in the Technical Sections.
   4. Provide weekly copies of manufacturer's representatives field notes and data to Contractor.

1.06 PLANNING PHASE

A. Overview of Planning Phase:
   1. Define approach and timing for Commissioning.
   2. Obtain Engineer approval of draft Test Plans.

B. Test Plans.
   1. Define approach and timing for:
      a. Testing and Training Phases.
         1) Major systems, with separate plans for each system.
      b. Start-Up Phase.
      c.
   2. Source Test (Factory Acceptance Test) and Functional Test Plans:
      a. As specified in this Section and other Technical Sections.
      b. Based on approved Shop Drawings.
      c. Prepared by the Contractor.
      d. Include the following items for each test:
         1) Purpose of the test.

2) Identification of each item of equipment/system to be tested, including system designation, location, tag number, control loop identifier, etc.
3) Description of the pass/fail criteria that will be used.
4) Listing of pertinent reference documents (Contract and industry standards or sections applicable to the testing).
a) Credentials of test personnel.
5) Test equipment:
a) Include Product Data for the test equipment.
b) Appropriate calibration records.
(1) Drawings or photographs of test stands and/or test apparatus.
6) Duration: Determine test durations with Owner's input.
7) Detailed step-by-step test procedures.
a) Level of detail shall be sufficient for the witness to follow the steps.

e. Define for Functional Testing:
1) Required temporary systems (pumps, piping, etc.).
2) Shutdown requirements for existing systems.

f. Furnish labor, power, tools, equipment, instruments, and services required for and incidental to testing activities.

3. Test forms minimum requirements:
a. Name of product to be tested.
b. Test date.
c. Names of persons conducting the test.
d. Names of persons witnessing the test, where applicable.
e. Test data.
f. Applicable project requirements as specified in the Technical Sections.
g. Check offs for each completed test or test step.
h. Place for signature of person conducting tests and for the witnessing person, as applicable.

4. Owner responsibilities:
a. Owner will schedule staff within the constraints of their workloads.
1) Those who will participate in this test have existing full-time work assignments, and testing is an additional assigned work task, therefore, scheduling is imperative.
2) Treatment facilities are typically operated on an around-the-clock basis and are staffed in work shifts.
1) Maximum hours per day available for commissioning activities: 4.
2) Days available for commissioning activities: Monday to Thursday.
3) Scheduling coordination with the CC.

5. CC is responsible for the following:
a. Coordinate schedule with the Owner's personnel and manufacturer's representatives (instructors).

C. Test Reports:
1. Minimum requirements:
a. Title.
b. Abstract.
c. Equipment.
d. Procedures.

e. Results.
1) Complete disclosure of the calculation methodologies.
f. Conclusions.
g. Signature by an authorized party.
h. Appendices.
1) Completed test forms signed by witnesses.

2. Water Management Plan:
a. Requirements:
1) Demonstrate how water will be produced, conveyed, treated, recycled, and or disposed until testing verifies specified requirements.

3. Commissioning Schedule:
a. Content:
1) Comply with Attachment G - Functional Testing Requirements and provide activities organized by system and subsystem.
2) Include:
a) Source Testing when required.
b) Functional Testing.
c) Owner Training.
3) Comply with Attachment F - Commissioning Roles and Responsibilities Matrix.
b. Procedures:
1) Submit Commissioning Schedule as specified in Section 01_32_21 - Schedules and Reports.

1.07 TESTING AND TRAINING PHASE

A. Overview of Testing and Training Phase:
1. General:
a. Contractor tests the Work to verify it meets the Contract requirements.
b. Contractor trains the Owner to operate and maintain the Work.
2. Contractor responsibilities:
a. Furnish labor, tools, equipment, instruments, and services required for and incidental to completing Commissioning activities in accordance with the approved Commissioning Plans.
3. Owner responsibilities:
a. Furnish labor, power, chemicals, and services required for and incidental to completing Commissioning activities in accordance with the approved Commissioning Plans.
b. Owner provided services, equipment, and/or materials to be as specified in Section 01_11_00 - Summary of Work.

B. Source Testing:
1. As specified in the Technical Section.
2. Source Test Plan:
a. Engineer approval of Source Test Plan required prior to testing.
3. Witnessed in person:
a. As specified in the Technical Section.

b. Contractor is responsible for trip costs associated with Owner's and Engineer's representatives.
    1) Transportation:
        a) Commercial airline costs to and from SEA-TAC, including related fees.
        b) Rental car to and from arrival airport, hotel, and test site, including related fees.
    2) Hotel/Meals:
        a) Hotel with an American Automobile Association 3 Diamond rating or higher equivalent for single occupancy room per person per day.
        b) Meal allowance based on state government per diem guidelines per test site location.
c. When factory is located outside of the United States, Contractor is responsible for costs associated with additional security of Owner's and Engineer's representatives, including armed escorts, as determined appropriate by the Owner and/or Engineer.

4. Virtual witness testing:
    a. As specified in the Technical Sections.
    b. Contractor is responsible for costs associated with virtual witness.
    c. Provide the following:
        1) An agenda detailing start time of each major phase in the procedure defined in the approved Test Plan.
        2) A dedicated operator (separate from the test technician) to operate the camera, provide commentary throughout test, and inspect devices at the request of the attendees.
    d. Online meeting platform: Microsoft Teams.
    e. Share video through a high-definition camera.
    f. Establish methods to communicate, convey, and record information clearly even in environments with loud background noise.
        1) Electronic feed for screen sharing of the control panel, HMI, or other screens used throughout testing.
        2) Provide recording of virtual sharing within 1 day after testing.
    g. Test run of virtual sharing a minimum of 1 week prior to the test:
        1) Use current record documents in PDF format.
        2) Provide recording of virtual sharing within 1 day after the test run.
        3) Engineer approval of test run virtual sharing is required before Source Testing.
5. If the Source Test is not ready on the scheduled date or if the Source Test fails:
    a. Contractor is responsible for associated costs:
        1) First test costs that are non-refundable, if applicable.
        2) Repeat test costs:
            a) Trip costs, if applicable.
        3) Virtual witness costs, if applicable.
6. Source Testing is complete after successful testing, submittal of test report, and Manufacturer's Certificate of Source Testing.
7. Engineer approval of Source Testing Report is required.

C. Installation Verification:
    1. Overview:
        a. Verifying the installation of equipment to be in accordance with Manufacturer's Instructions.
    2. Prerequisite:
        a. Engineer approval of Source Testing Report.
    3. Perform checks:
        a. Structural anchorage check.
        b. Electrical energization check.
            1) As specified in the flowchart shown in Attachment A.
        c. Health and safety check.
    4. Submit Manufacturer's Certificate of Installation Verification.
    5. Engineer approval of Manufacturer's Certificate of Installation Verification is required.

D. Functional Testing:
    1. Overview:
        a. Testing the function of a system or subsystem.
    2. Prerequisites:
        a. Engineer approval of Manufacturer's Certificate of Installation Verification.
        b. Engineer approval of Functional Test Plan required prior to testing.
        c. Draft Operations and Maintenance Manual as specified in Section 01_78_24 - Operations and Maintenance Manual.
        d. Completed pipe, valve, and gate labeling of system or subsystem.
            1) As specified in Section 40_05_00.03 - Pipe Identification prior to the start of Functional Testing.
    3. Witnessed.
    4. Discipline checks:
        a. Verify support systems function properly, such as seal water, pipes, valves, etc.
        b. As specified in the individual Technical Sections.
    5. Consecutive Day Test:
        a. Operate the Work as specified in Attachment G - Functional Testing Requirements and as specified in the individual Technical Sections.
            1) Successful completion of subsystem testing required prior to system testing.
        b. Failure response time:
            1) Be equipped and ready to provide emergency repairs, adjustments, and corrections to comply with the "Significant Interruption Duration" requirements as specified in Attachment G - Functional Testing Requirements.
        c. Duration:
            1) As specified in Attachment G - Functional Testing Requirements.
            2) Restart the consecutive day test when the system performance failures exceed the "Significant Interruption Duration" time period specified in Attachment G - Functional Testing Requirements.
                a) Individual equipment/system failures that are corrected within the "Significant Interruption Duration" time specified in Attachment G - Functional Testing Requirements shall not

require the consecutive day test to be restarted unless the failure recurs.

b) Engineer has the authority to reject the consecutive day test if individual equipment/system failures are repetitive.

6. Instrumentation and controls tests.
   a. Loop Validation Tests.
   b. Complete End-to-End Testing (CEET):
      1) Signal are tested from the field device through the PLC program, the network, and all the way to the operator's HMI graphic screens.
7. Restore to condition prior to testing:
   a. Remove, clean, and replace permanent and temporary filters and strainers in pipeline systems.
   b. Dewater and clean sumps.
8. Submit Manufacturer's Certificate of Functional Compliance.
9. Engineer approval of Manufacturer's Certificate of Functional Compliance is required.

E. Documentation:
   1. Provide records generated during Commissioning Phase of Project, including, but not limited to:
      a. Training documentation.
      b. Manufacturer's Certificate of Source Testing.
      c. Manufacturer's Certificate of Installation Verification.
      d. Manufacturer's Certificate of Functionality Compliance.
      e. Daily logs of equipment/system testing identifying tests conducted and outcome.
      f. Test forms and documentation.
      g. Functional Testing results.
      h. Logs of time spent by manufacturer's representatives performing services on the job site.
      i. Equipment lubrication records.
      j. Electrical phase, voltage, and amperage measurements.
      k. Insulation resistance measurements.
      l. Bearing temperature measurements.
      m. Data sheets of control loop testing, including testing and calibration of instrumentation devices and setpoints.
      n. Provide: 1 electronic copy in format and 3 hard copies organized in notebooks.
      o. Due date: Within 14 calendar days of Substantial Completion.
   2. Engineer approval of documentation is required.

F. Owner Training:
   1. Train Owner's staff on the operation and maintenance of the equipment/system.
      a. Provide Owner staff with state regulatory agency approved training CEUs.
   2. Train on each topic of the approved Operation and Maintenance Manual.
      a. Include classroom instruction and field demonstration with all necessary tools and test equipment.
   3. Training tailored to the skills and job classifications of the staff attending the classes (e.g., plant superintendent, treatment plant operator, maintenance technician, electrician, etc.).

4. Training outcomes:
    a. Owner's staff can safely operate, maintain, and repair the equipment/systems provided as recommended by the manufacturer.
5. Training plan:
    a. CC shall meet with Engineer and Owner's designated training coordinator to develop list of personnel to be trained and to establish expected training outcomes and objectives at least 60 calendar days prior to commissioning of equipment/system.
    b. Coordinate and arrange for manufacturer's representatives to provide both classroom-based learning and field (hands-on) training, based on training module content and stated learning objectives.
    c. Conduct classroom training at location designated by Owner.
    d. Scope and sequence:
        1) Plan and schedule training in the correct sequence to provide prerequisite knowledge and skills to trainees.
            a) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.
        2) If multiple classes are needed to meet the training objectives, they shall be included in the training plan.
6. Owner Training Schedule:
    a. Schedule Owner's staff training within the constraints of their workloads.
        1) Those who will participate in this training have existing full-time work assignments, and training is an additional assigned work task, therefore, scheduling is imperative.
        2) Owner staff work schedules regularly shift, as treatment facilities are typically operated on an around-the-clock basis.
        3) Maximum training hours per week: 16.
        4) Days available for training:
            a) Monday to Thursday.
    b. Training scheduling coordination:
        1) CC is responsible for the following:
            a) Coordinate schedule for training periods with the Owner's personnel and manufacturer's representatives (instructors).
        2) Complete Owner Training no sooner than 15 calendar days prior to Functional Testing of each system.
    c. Class logistics:
        1) Delivery time minimum: 2 hours.
        2) Delivery time maximum: 4 hours.
        3) Class agenda:
            a) Refreshment break: One 10-minute break.
            b) Meal break: One 45-minute break, unless otherwise specified.
            c) Schedule refreshment breaks and meal breaks to meet the class needs and Owner work rules.
        4) Schedule specific sessions:
            a) Minimum of 30 days in advance to allow Owner staffing arrangements to take place.
            b) At the times requested by the Owner, within the period 7 a.m. to 4 p.m. Monday through Friday.
                (1) Times scheduled will be at Owner's discretion.
            c) Owner approval and confirmation required for session schedules.

d) Provide minimum of 1 sessions for each class unless otherwise noted.
(1) The purpose of having multiple sessions on each class is to accommodate the attendance of as many Owner personnel working different shifts as possible.
e) A maximum of 1 session per day for each class.

d. Number of students:
1) Estimated class size maximum: 10 staff.
2) Engineer will confirm the headcount 1 week prior to the class so that the instructor can provide the correct number of training aids for students.

7. Submittals:
a. Submit Training Plan Schedule 30 calendar days before the first scheduled training session, including, but not limited to, lesson plans, participant materials, instructor's resumes, and training delivery schedules.
b. Submit training documentation, including the following:
1) Training plan:
a) Training modules.
b) Scope and sequence statement.
c) Contact information for manufacturer's instructors. including name, phone, and e-mail address.
d) Instructor qualifications.
2) Training program schedule:
a) Format: Bar chart:
(1) Include in the Project Progress Schedule.
b) Contents:
(1) Training modules and classes.

8. Lesson plans:
a. Divide training into discrete modules appropriate for the equipment and trades.
b. State performance-based learning objectives in terms of what the trainees will be able to do at the end of the lesson.
c. Define student conditions of performance and criteria for evaluating instructional success.
d. Minimum requirements:
1) Hands-on demonstrations planned for the instructions.
2) Cross-reference training aids.
3) Planned training strategies such as whiteboard work, instructor questions, and discussion points or other planned classroom or field strategies.
4) Attach handouts cross-referenced by section or topic in the lesson plan.
5) Indicate duration of outlined training segments.
e. Provide instruction lesson plans for each trade:
1) Detailed component description:
a) Identify each component function and describe in detail.
b) Identify equipment's mechanical, electrical, and electronic components and features.
c) Where applicable, group relative components into subsystems.
d) Identify and describe in detail equipment safety features, permissive and controls interlocks.

2) Equipment operation:
    a) Describe equipment's operating (process) function and system theory.
    b) Describe equipment's fundamental operating principles and dynamics.
    c) Identify support equipment associated with the operation of subject equipment.
    d) Detail the relationship of each piece of equipment or component to the subsystems, systems, and process.
    e) Cite hazards associated with the operations, exposure to chemicals associated with the component, or the waste stream handled by the component.
    f) Specify appropriate safety precautions, equipment, and procedures to eliminate, reduce, or overcome hazards.
3) Define Preventative Maintenance (PM) inspection procedures required on equipment in operation, spot potential trouble symptoms (anticipate breakdowns), and forecast maintenance requirements (predictive maintenance).
    a) Review preventive maintenance frequency and task analysis table.
4) Define equipment Corrective Maintenance (CM) troubleshooting:
    a) Describe recommended equipment preparation requirements as they relate to specific craft problems.
    b) Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.
    c) Provide component specific troubleshooting checklists as they relate to specific craft problems.
    d) Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.
    e) Perform at least 2 hands-on demonstrations of common corrective maintenance repairs.
5) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

9. Training instruction format:
    a. Training for operations and maintenance personnel shall be provided as one entity.
    b. Instructors shall apply adult education best practices, emphasizing learner participation and activity.
    c. Lecturing should be less than 30 percent of class time.
    d. Training delivery may include problem solving, question/answer, hands-on instruction, practice, evaluation/feedback tools, and lecture to support training objectives.
    e. Conduct hands-on instruction according to the following descriptions:
        1) Present hands-on demonstrations of at least the following tasks:
            a) Proper start-up, shutdown, and normal and alternative operating strategies.
            b) Common corrective maintenance repairs for each group.
            c) Recommended procedures to check/test equipment/system following a corrective maintenance repair.

d) Preventative maintenance points.
e) Calibration, if applicable.

2) Use tools and equipment provided by manufacturer to conduct the demonstrations.
a) Submit requests for supplemental assistance and facilities with the Contractor's proposed lesson plans.

3) Contractor remains responsible for equipment disassembly or assembly during hands-on training situations involving equipment disassembly or assembly by Owner's personnel.

f. Training aids:
1) Instructors shall provide needed audio-visual devices such equipment (televisions, video recorder/player, computer, projectors, screens, easels, etc.), models, charts, etc., for each class.
2) Instructor to confirm with Engineer in advance of each class that the classroom will be appropriate for the types of audiovisual equipment to be employed.

10. Training sessions:
a. Provide training sessions for equipment/system as specified in the individual equipment/system section.
b. Include the following information in the agenda:
1) Instructor name.
2) Listing of subjects to be discussed.
3) Time estimated for each subject.
4) Allocation of time for Owner staff to ask questions and discuss the subject matter.
5) List of documentation to be used or provided to support training.
c. Owner may request that particular subjects be emphasized, and the agenda be adjusted to accommodate these requests.
d. Digitally record audio and video of each training session.
1) Include classroom and field instruction with question and answering periods.
2) Engineer approval required for producer of video materials from one of the following options:
a) Qualified, professional video production company or individual.
3) Record in digital format and recording shall become property of the Owner with exclusive rights.
a) No video recording agreements will be entered into by the Owner.
4) Media:
a) Video quality shall be 720p HD or greater in MPG, AVCHD, AVI, or MP4 format.
b) Digital color video format.
c) Provide audio portion of the composite CD sufficiently free from electrical interference and background noise to provide complete intelligibility of oral report.
d) Identification: On each copy provide a label with the following information:
(1) Name of training.
(2) Date video was recorded.
e) Display continuous running time.

f) At start of each video recording, record training class name, date, and instructor's name.
g) Provide audio quality that is not degraded during the recording of the field sessions due to background noise, space, distance or other factors.

5) Contractor shall provide a written release from all claims to the recorded training material produced, if required.

e. Distribute copies of the agenda to each student at the beginning of each training class.
f. Trainees will keep training materials and documentation after the session.
g. Distribute Training Evaluation Form following each training session.
1) Training Evaluation Form is included in this Section.
2) Return completed Training Evaluation Forms to Owner's designated training coordinator immediately after session is completed.
3) Revise training sessions judged "Unsatisfactory" by a majority of attendees.
a) Conduct training sessions again until a satisfactory rating is achieved.

11. Engineer approval of Owner Training is required.

1.08 START-UP PHASE

A. Overview of Start-Up Phase:
1. General:
a. Confirm reliability requirements.

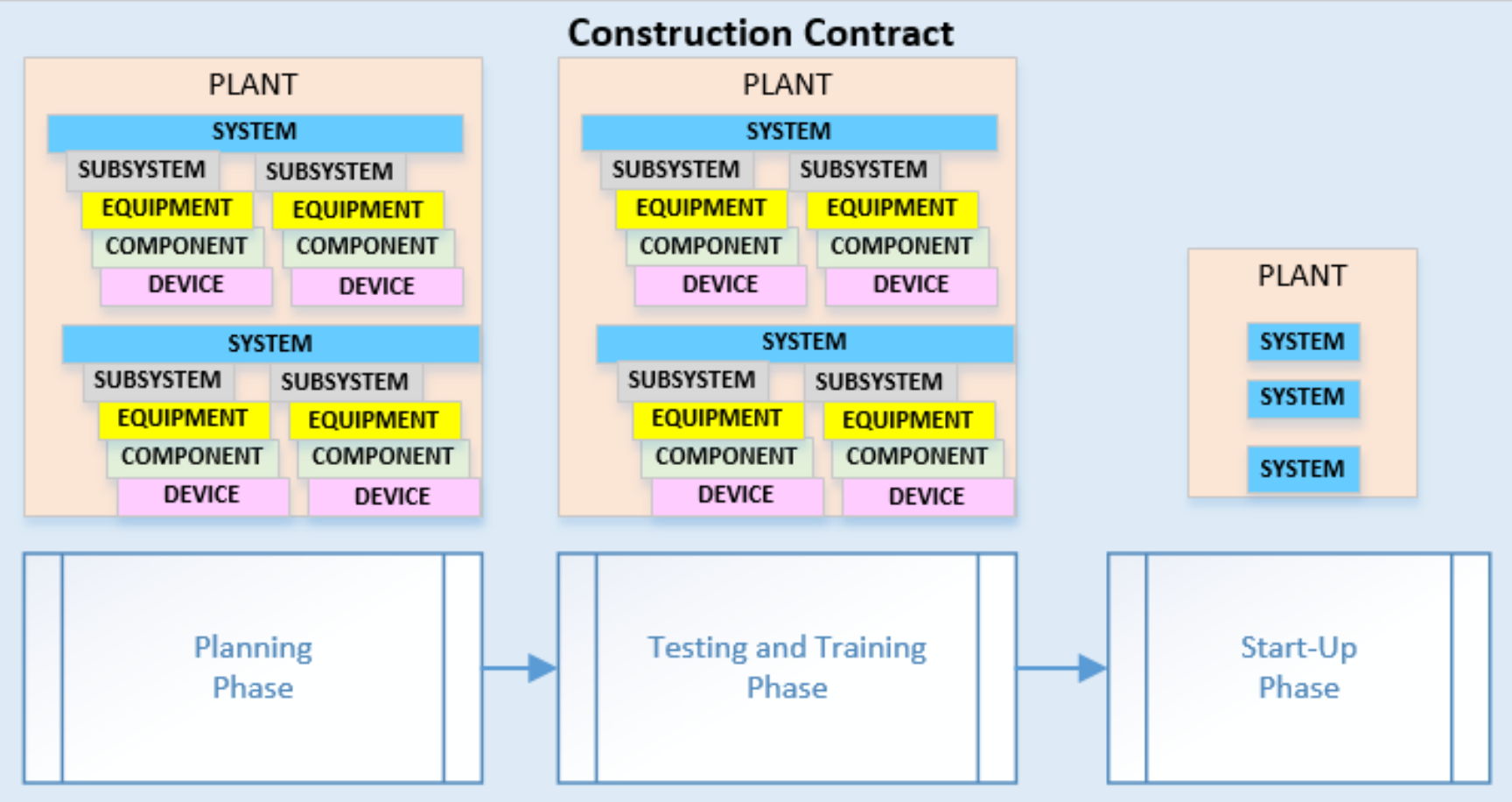
B. Start-Up Period:
1. Contractor responsibilities:
a. Support Owner to operate the Work.
2. Owner responsibilities:
a. Owner to operate the Work.
b. Owner-provided services, equipment, and/or materials to be as specified in Section 01_11_00 - Summary of Work.
c. Furnish labor, tools, equipment, instruments, and services required for and incidental to completing commissioning activities in accordance with the approved Commissioning Plans.
3. Prerequisites:
a. Engineer approval of Testing and Training Phase.
4. Witnessed.
5. Duration: 7 days.
6. Engineer approval of Start-Up Period is required to achieve substantial completion.

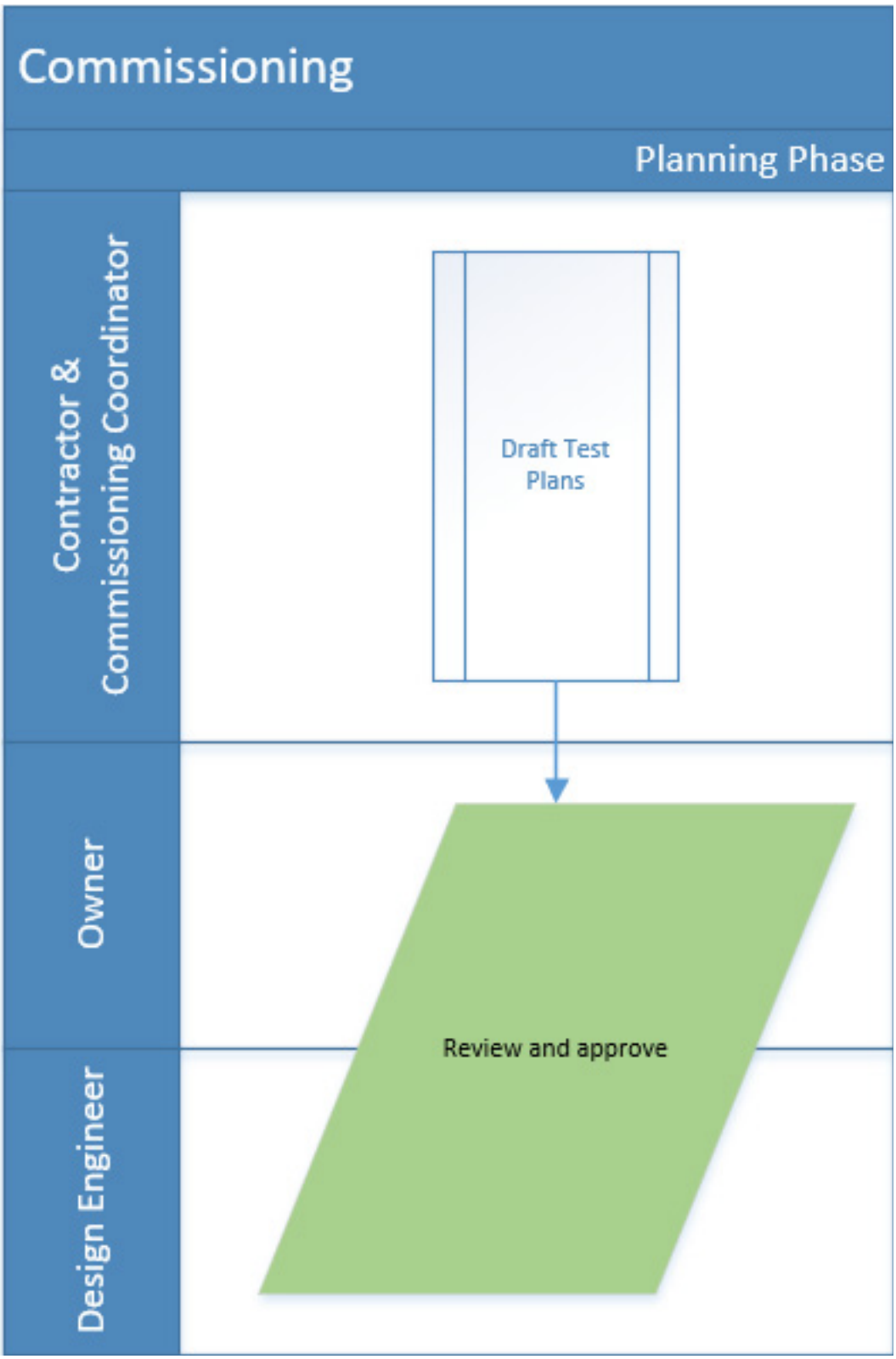
PART 2 PRODUCTS (NOT USED)

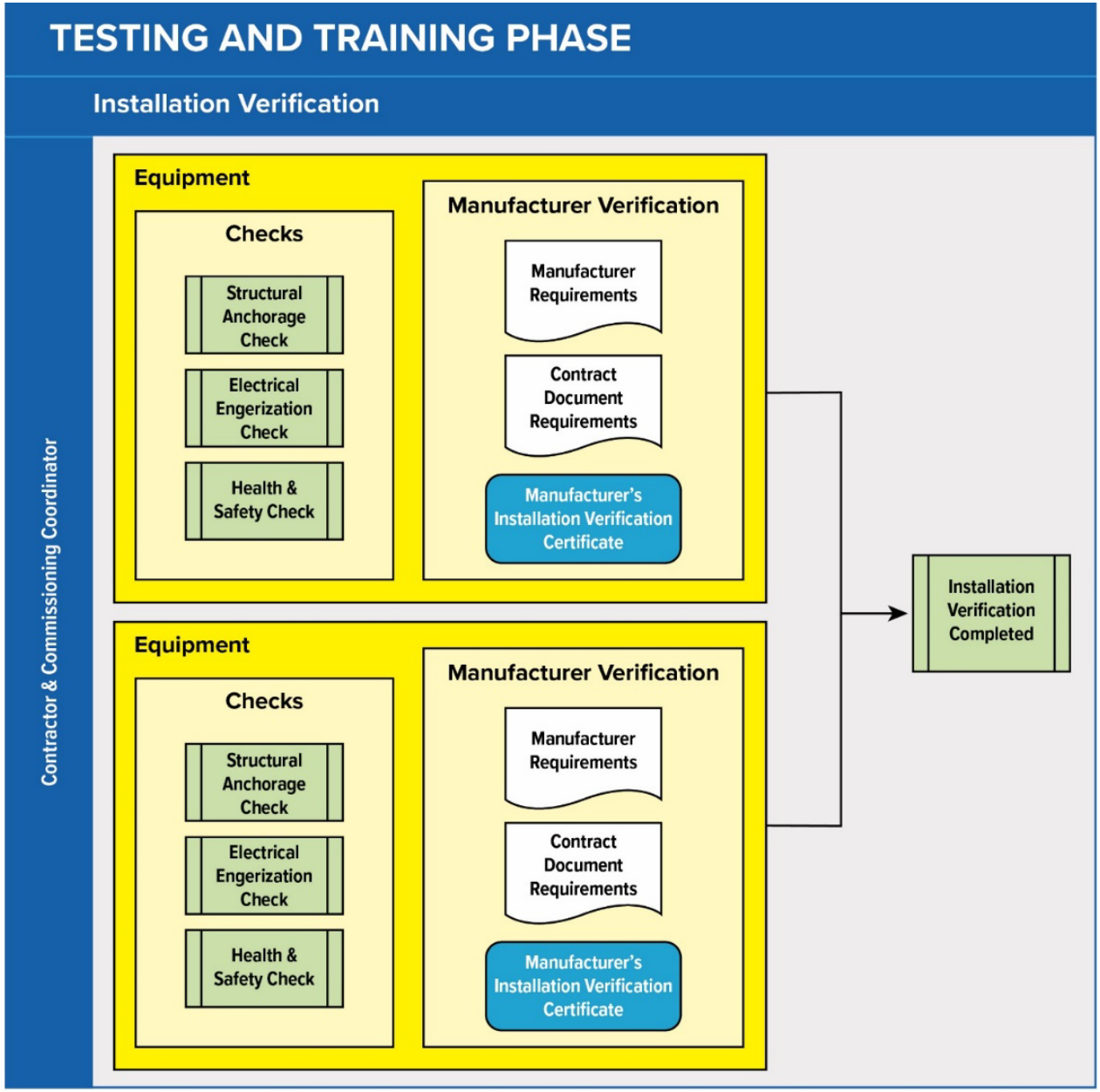
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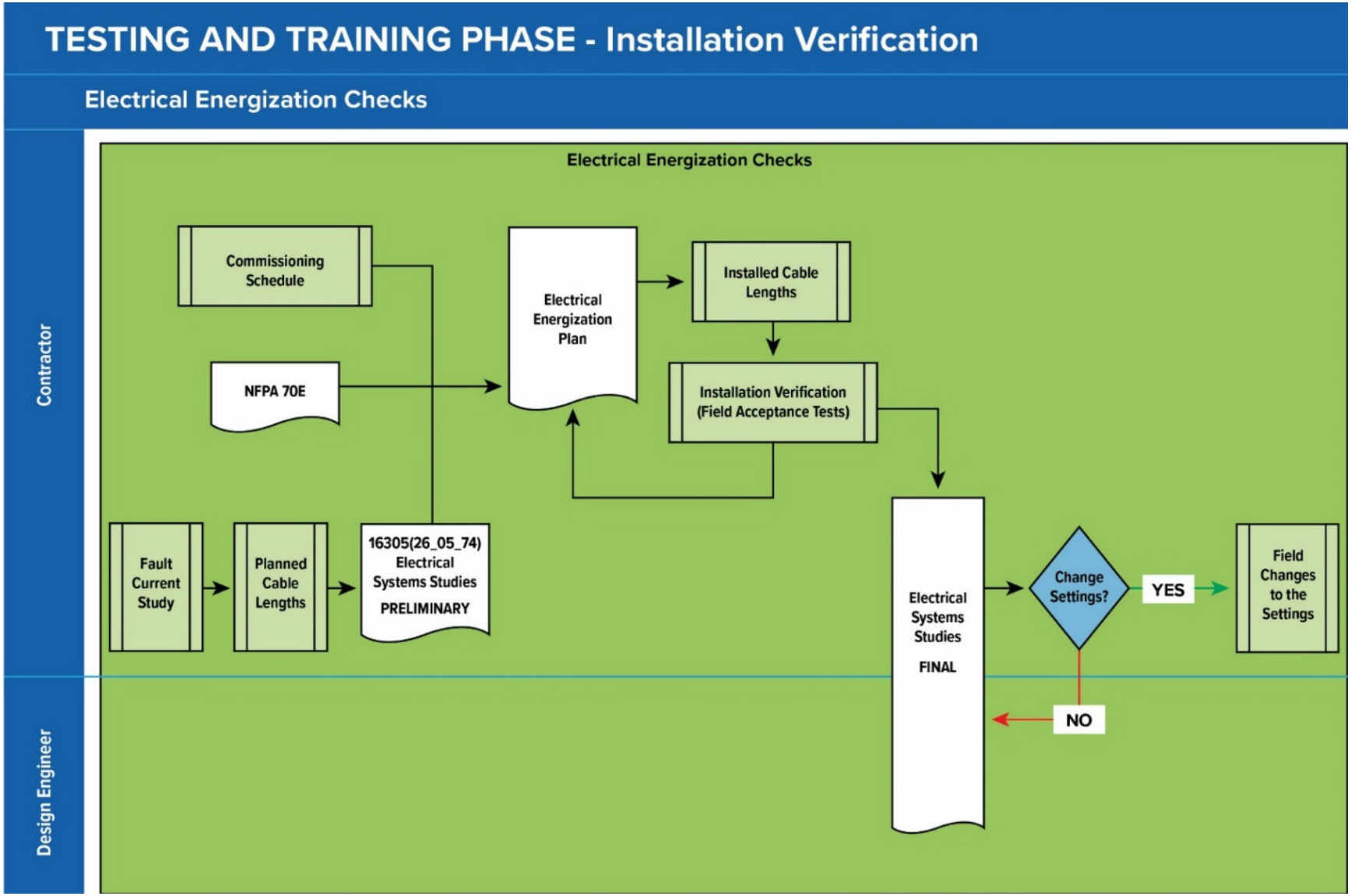
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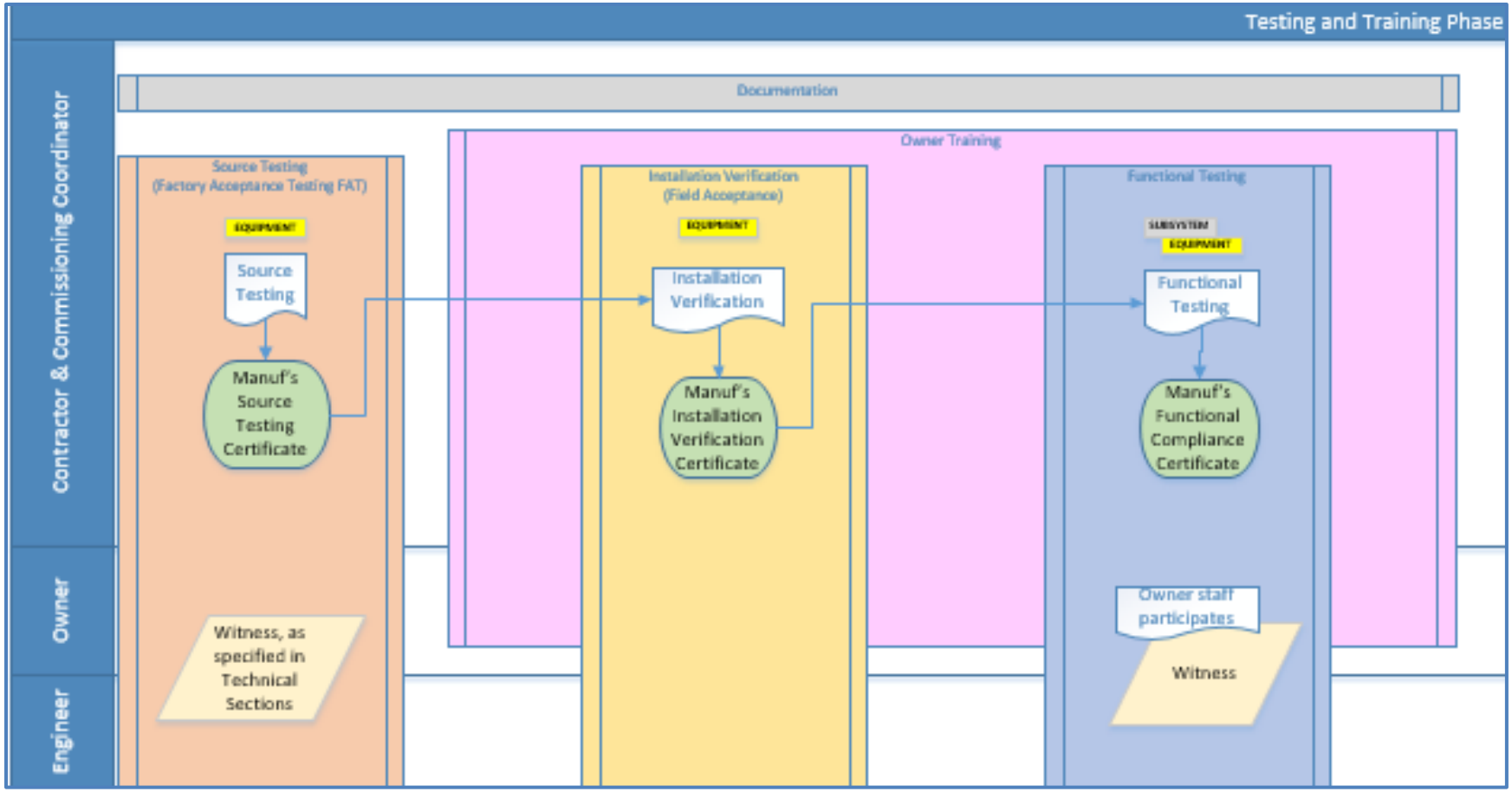
ATTACHMENT A - COMMISSIONING FLOWCHARTS

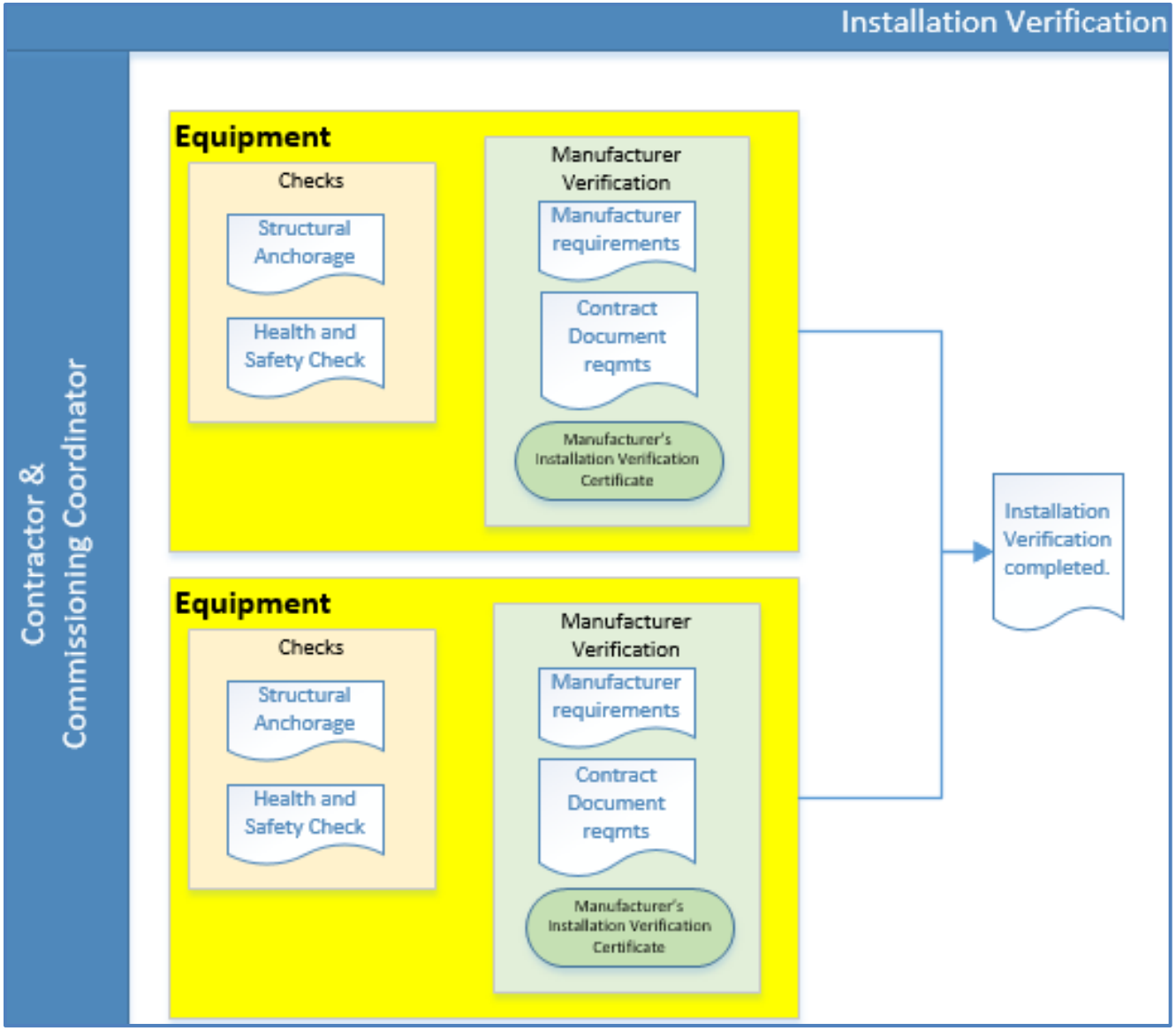

Construction Contract
PLANT
SYSTEM
SUBSYSTEM
SUBSYSTEM
EQUIPMENT
EQUIPMENT
COMPONENT
COMPONENT
DEVICE
DEVICE
SYSTEM
SUBSYSTEM
SUBSYSTEM
EQUIPMENT
EQUIPMENT
COMPONENT
COMPONENT
DEVICE
DEVICE
PLANT
SYSTEM
SUBSYSTEM
SUBSYSTEM
EQUIPMENT
EQUIPMENT
COMPONENT
COMPONENT
DEVICE
DEVICE
SYSTEM
SUBSYSTEM
SUBSYSTEM
EQUIPMENT
EQUIPMENT
COMPONENT
COMPONENT
DEVICE
DEVICE
PLANT
SYSTEM
SYSTEM
SYSTEM
Planning Phase
Testing and Training Phase
Start-Up Phase

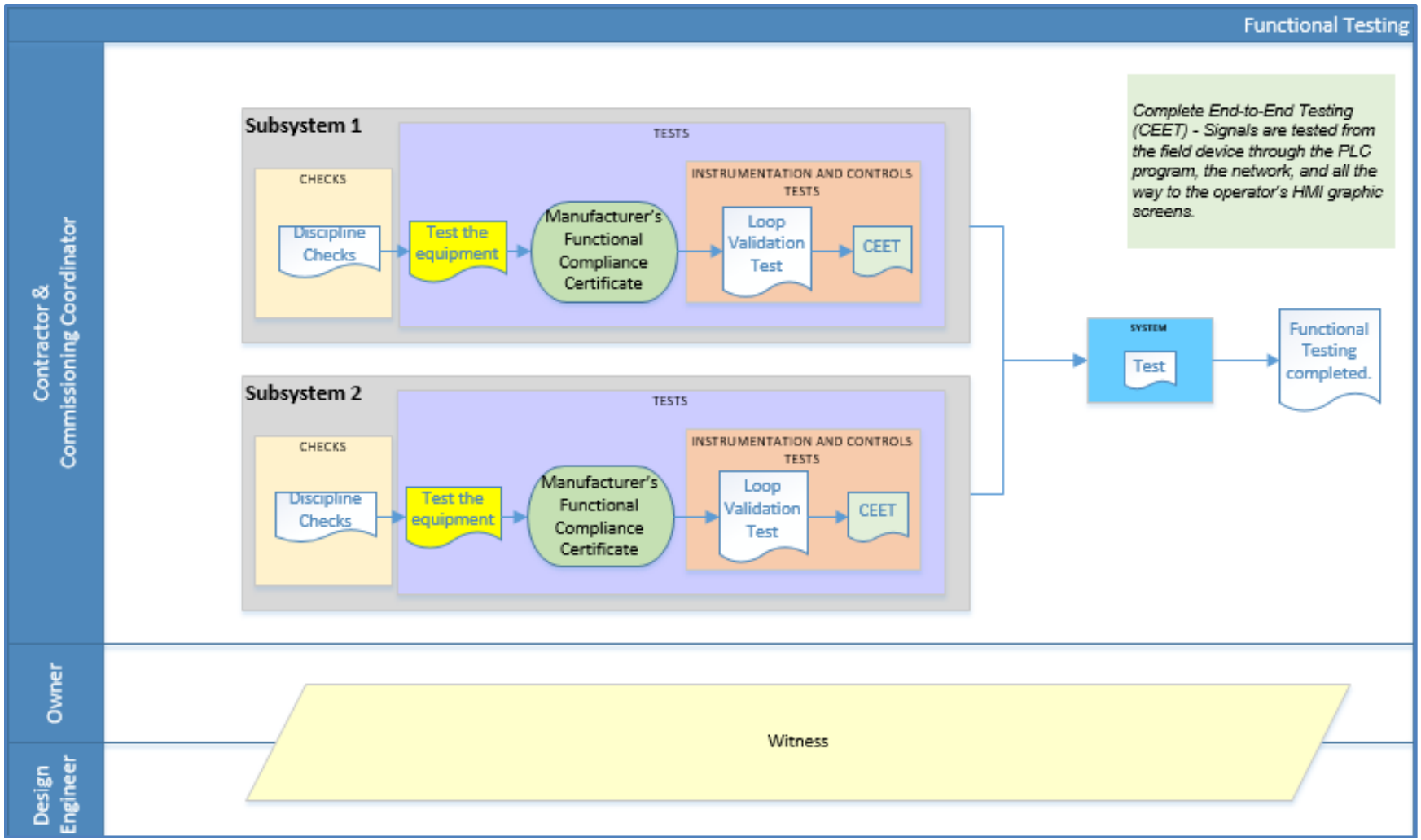

Commissioning
Planning Phase
Contractor & Commissioning Coordinator
Draft Test Plans
Owner
Review and approve
Design Engineer

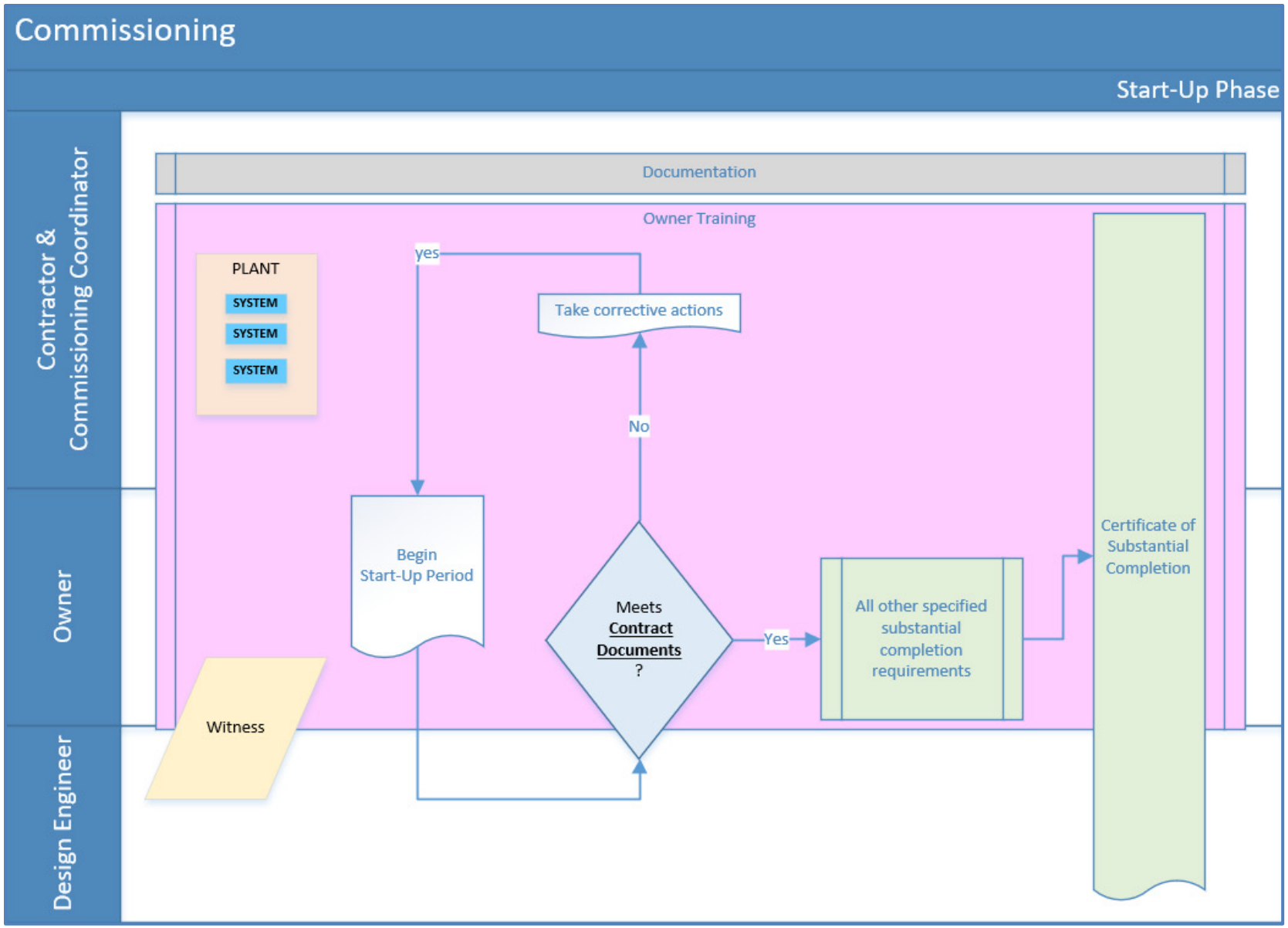

TESTING AND TRAINING PHASE
Installation Verification
Contractor & Commissioning Coordinator
Equipment
Checks
Structural Anchorage Check
Electrical Engerization Check
Health & Safety Check
Manufacturer Verification
Manufacturer Requirements
Contract Document Requirements
Manufacturer's Installation Verification Certificate
Equipment
Checks
Structural Anchorage Check
Electrical Engerization Check
Health & Safety Check
Manufacturer Verification
Manufacturer Requirements
Contract Document Requirements
Manufacturer's Installation Verification Certificate
Installation Verification Completed


TESTING AND TRAINING PHASE - Installation Verification
Electrical Energization Checks
Contractor
Design Engineer
Electrical Energization Checks
Commissioning Schedule
NFPA 70E
Electrical Energization Plan
Installed Cable Lengths
Installation Verification (Field Acceptance Tests)
Fault Current Study
Planned Cable Lengths
16305(26_05_74) Electrical Systems Studies PRELIMINARY
Electrical Systems Studies FINAL
Change Settings?
YES
NO
Field Changes to the Settings


Testing and Training Phase
Contractor & Commissioning Coordinator
Owner
Engineer
Documentation
Owner Training
Source Testing
(Factory Acceptance Testing FAT)
EQUIPMENT
Source Testing
Manuf's Source Testing Certificate
Witness, as specified in Technical Sections
Installation Verification
(Field Acceptance)
EQUIPMENT
Installation Verification
Manuf's Installation Verification Certificate
Functional Testing
SUBSYSTEM
EQUIPMENT
Functional Testing
Manuf's Functional Compliance Certificate
Owner staff participates
Witness


Installation Verification
Contractor & Commissioning Coordinator
Equipment
Checks
Structural Anchorage
Health and Safety Check
Manufacturer Verification
Manufacturer requirements
Contract Document reqmts
Manufacturer's Installation Verification Certificate
Equipment
Checks
Structural Anchorage
Health and Safety Check
Manufacturer Verification
Manufacturer requirements
Contract Document reqmts
Manufacturer's Installation Verification Certificate
Installation Verification completed.


Functional Testing
Contractor & Commissioning Coordinator
Owner
Design Engineer
Subsystem 1
TESTS
CHECKS
Discipline Checks
Test the equipment
Manufacturer's Functional Compliance Certificate
INSTRUMENTATION AND CONTROLS TESTS
Loop Validation Test
CEET
Subsystem 2
TESTS
CHECKS
Discipline Checks
Test the equipment
Manufacturer's Functional Compliance Certificate
INSTRUMENTATION AND CONTROLS TESTS
Loop Validation Test
CEET
Complete End-to-End Testing (CEET) - Signals are tested from the field device through the PLC program, the network, and all the way to the operator's HMI graphic screens.
SYSTEM
Test
Functional Testing completed.
Witness


Commissioning
Start-Up Phase
Contractor & Commissioning Coordinator
Owner
Design Engineer
Documentation
Owner Training
PLANT
SYSTEM
SYSTEM
SYSTEM
yes
Take corrective actions
No
Begin Start-Up Period
Meets Contract Documents ?
Yes
All other specified substantial completion requirements
Certificate of Substantial Completion
Witness

ATTACHMENT B - MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER _____ EQPT/SYSTEM _____

PROJECT NAME _____ EQPT TAG NO. _____

PROJECT NO. _____ EQPT SERIAL NO. _____

SPECIFICATION NO. _____

SPECIFICATION TITLE _____

Comments: _____

_____

_____

_____

_____

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: _____, 20 _____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

_____

(Authorized Signature)

If applicable, Witness Name *(print)*: _____

_____

(Witness Signature)

ATTACHMENT C - MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

OWNER _____ EQPT/SYSTEM _____

PROJECT NAME _____ EQPT TAG NO. _____

PROJECT NO. _____ EQPT SERIAL NO. _____

SPECIFICATION NO. _____

SPECIFICATION TITLE _____

I hereby certify the installation of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

1. Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

_____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

ATTACHMENT D - MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

OWNER _____ EQPT/SYSTEM _____

PROJECT NAME _____ EQPT TAG NO. _____

PROJECT NO. _____ EQPT SERIAL NO. _____

SPECIFICATION NO. _____

SPECIFICATION TITLE _____

I hereby certify the Functional Testing of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

1. Attach test results with collected data and test report.
2. Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

_____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

WITNESSES:

By Owner's Authorized Representative: _____

(Authorized Signature)

By Engineer's Authorized Representative: _____

(Authorized Signature)

ATTACHMENT E - TRAINING EVALUATION FORM

TRAINING EVALUATION FORM

EQUIPMENT/SYSTEM ITEM: _____

VENDOR/MANUFACTURER: _____

DATE: _____ NAME OF REPRESENTATIVE: _____

1.	Was representative prepared?	Acceptable	Unacceptable	or	N/A
2.	Was an overview description presented?	Acceptable	Unacceptable	or	N/A
3.	Were specific details presented for system components?	Acceptable	Unacceptable	or	N/A
4.	Were alarm and shutdown conditions clearly presented?	Acceptable	Unacceptable	or	N/A
5.	Were step-by-step procedures for starting, stopping, and troubleshooting presented?	Acceptable	Unacceptable	or	N/A
6.	Were routine/preventative maintenance items clearly identified?	Acceptable	Unacceptable	or	N/A
7.	Was the lubrication schedule (if any) discussed?	Acceptable	Unacceptable	or	N/A
8.	Was the representative able to answer all questions?	Acceptable	Unacceptable	or	N/A
9.	Did the representative agree to research and answer unanswered questions?	Acceptable	Unacceptable	or	N/A
10.	Comments: _____				
11.	Overall Rating	Satisfactory	Unsatisfactory		

Note:

Sessions judged “Unsatisfactory” by a majority of attendees shall be revised and conducted again until a satisfactory rating is achieved.

ATTACHMENT F- COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
Testing and Training Phase				
Source Testing				
	Source Testing	Witnessed as specified in the Technical Sections.	Lead	Witnessed as specified in the Technical Sections. Review
	Manufacturer's Certificate of Source Testing	No Action	Lead	Review
Installation Verification				
	Structural Anchorage Check	Witness	Lead	Review
	Health and Safety Check	Witness	Lead	Review
	Manufacturer Requirements Verification	No Action	Lead	Review
	Contract Documents Verification	No Action	Lead	Review
	Manufacturer's Certificate of Installation Verification	No Action	Lead	Review
Functional Testing				
	Checks	Witness	Lead	Witness, Review
	Tests	Witness	Lead	Witness, Review
	Manufacturer's Certificate of Functional Compliance	No Action	Lead	Witness, Review
System Testing				
	System Testing	Witness	Lead	Witness, Review
Start-Up Phase				
	Start-Up	Lead	Support	Witness, Review

Legend:

Lead: Primarily responsible for organization, coordination, and execution of task work product or result.
Support: Assist the lead with organization, coordination, and execution of task work product or result.
Witness: Observe and document completion of task work product or result.
No Action: Limited or no involvement.
Review: Approve for compliance with Contract Documents or reject.

ATTACHMENT G - FUNCTIONAL TESTING REQUIREMENTS

FUNCTIONAL TESTING REQUIREMENTS

System	Subsystem	Consecutive Day Test Duration (Days)	Significant Interruption Duration (Hours)	Test Liquid	System Operated By
Secondary Clarification					
	Dewatering Pump	1	2	Test Water	Contractor
WAS					
	Pump Discharge Valves	3	2	Test Water	Contractor
	WAS Pumping	3	2	Test Water	Contractor
Entire Solids Handling Flow Stream				Solids from process	Contractor
	Area 530 Thickened Sludge Pumps	7	4	Solids from process	Contractor
	Area 530 Elec. Actuated Valves	3	4	Solids from process	Contractor
	Area 530 Solenoids	2	2	W3	Contractor
	Area 530 Sump Pumps	2	4	Test Water	Contractor
	Area 530 Polymer/Sludge Mixing	3	2	Solids from process	Contractor
	Area 420 Sludge Pumps	7	4	Solids from process	Contractor
	Area 420 Solenoids	2	2	W3	Contractor
	Area 420 Sump Pumps	2	4	Test Water	Contractor
	Area 440 Mixers	7	4	Solids from process	Contractor
	Area 440 Solenoids	2	2	W3	Contractor
	Area 440 Odor Control System	7	4	Process air	Contractor
RAS					
	Pump Discharge Valves	3	2	Test Water	Contractor
	RAS Pumping	3	2	Test Water	Contractor

A. Schedule delays:
   1. Changes in the dates for Source Testing less than 30 days of the date provided in the latest approved Commissioning Schedule are considered delays.
   2. Contractor is responsible for associated costs resulting from delays:
      a. In person and/or virtual witnessing.
      b. Travel costs and witness labor costs.
         1) Witness labor costs at $250 per hour.

B. Repeat test costs:
   1. Contractor is responsible for associated costs for repeat testing:
      a. In person and/or virtual witnessing.
      b. Travel costs and witness labor costs.
         1) Witness labor costs at $250 per hour.

SECTION 01_75_19

WATER LEAKAGE TEST FOR CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Hydrostatic leakage test for concrete water-holding structures.

1.02 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Containment structure, lined: Liquid-containing structure with barrier coating or membrane applied to the inside surfaces to prevent leaking of contents to the outside.
   2. Containment structure, unlined: Liquid containing structure where only the concrete structure itself is used to prevent leaking of contents to the outside.
   3. Damp spots: Surfaces where visible moisture can be picked up by a dry hand.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination.

B. Pre-installation meetings.

C. Sequencing.

D. Scheduling.

1.04 SUBMITTALS

A. Product data.

B. Shop Drawings:
   1. Description and details of each evaporation/precipitation-measuring device anticipated for use during the test.

C. Samples.

D. Certificates.

E. Delegated Design Submittals.

F. Tests and evaluation reports:
   1. Results of water leakage test for each structure and for each portion of a structure designated for testing.

G. Manufacturer instructions.

H. Source quality control Submittals.

I. Field/site quality control Submittals.

J. Manufacturer reports.

K. Sustainable design Submittals.

L. Special procedure Submittals:
   1. Testing plan for each structure, or portion thereof, required to be tested.
      a. Describe methods of obtaining water for testing and of releasing water for disposal, including provisions for dechlorination if required.
      b. Include plans showing locations where measurements will be made and locations of evaporation/precipitation-measuring device.
      c. Indicate plans for filling and draining structure(s).
      d. Include schedule showing duration of test for each structure or cell to be tested, date and time for start of each test, dates and times of observations and measurements during the test, dates and times for closeout of testing procedures, and date for submittal of final results.
   2. Proposed procedures and products for repair of leaks.

M. Qualifications statements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Test structures and portions of structures listed in the following paragraphs for water leakage.
   1. Unless otherwise specified:
      a. Obtain required permits for discharging testing water.
      b. Provide dechlorination of such water if required by the permits.
      c. Prepare and fill the structures.
      d. Provide access and equipment required for testing and for recording test results.
      e. Take measurements and make observations required for testing.
   2. At all times during testing, the Engineer shall have access to observe measurements by others or to make independent measurements.

B. Test the following concrete structures for water leakage:
   1. Area 440 Sludge Storage Tanks.

C. Required preparation for testing is designated in this Section. Waiver of, or failure to complete preparations shall not change the testing criteria or approval criteria for the areas tested.

D. Retest structures and portions of structures until the evaluation criteria are satisfied.

3.02 TEST WATER SOURCE AND DISPOSAL

A. Water used for the first filling of the tank will be furnished by the Owner.
   1. Obtain water for leakage testing from plant water system (W3).

B. In the event that retesting is required, Contractor shall bear the cost of refilling the tank for subsequent tests.

C. After leakage testing is complete, Contractor shall dispose of water as directed by Owner.

3.03 PREPARATION

A. For each structure to be tested, prepare and submit a plan showing schedule and sequence of activities, method of filling, and methods of disposing of test water.

B. Sequencing requirements:
   1. Complete construction of concrete structure and cure concrete to obtain minimum specified 28-day compressive strength as specified in Section 03_30_00 - Cast-in-Place Concrete.
      a. Do not begin tests until all portions of structure are complete and have reached their minimum specified 28-day compressive strength.
      b. Do not begin tests until at least 14 days have passed since completion of the last concrete placement.
   2. Complete tests before:
      a. Covering any surface of the structure with materials that might mask the location of leaks or obscure damp concrete surfaces. Such coverings include, but are not limited to, basin bottom grout, masonry veneer, stucco, plaster, and other coatings.
      b. Installation of equipment, unless otherwise approved by the Engineer.
      c. Backfilling structures to elevations above the limits indicated in the following paragraphs.
   3. Liners and coatings:
      a. Install liners that are mechanically locked to the concrete surface during placement of plastic concrete and before leakage testing.
         1) Examine liners for pinholes, tears, and partially fused splices, complete required liner integrity testing, and make required repairs before commencing leakage testing.
      b. Unless otherwise specified, do not install surface-applied protective or decorative coatings and linings until leakage tests have been completed.

C. Weather requirements:
   1. Tests on structures with tops open to the atmosphere shall not be scheduled for periods when the 10-day weather forecast indicates a substantial change in weather patterns.

2. Measurements of water surface levels in the structure shall not be scheduled for periods when the weather forecast indicates a difference of more than 35 degrees Fahrenheit between the ambient temperature readings at the times of initial and final measurements.
3. Tests shall not be scheduled for periods when the 10-day weather forecast indicates that the water surface may freeze before the test is complete.

D. Groundwater requirements:
1. Bring groundwater to a level below the top of the floor slab and maintain at that level for the duration of the test.

E. Clean interior of structure:
1. Remove dirt, contaminants, and construction debris.
2. Flush floors and sumps to provide clean surfaces.
3. Remove standing water that would interfere with examination of surfaces, cracks, or joints.

F. Observe the structure, or portions of the structure being tested, for potential leak locations:
1. Give particular attention to cracks, open joints, voids, and honeycombed and repaired surfaces.
2. Visually observe openings, fitting, and pipe penetrations in the structure at both faces, if possible.
3. Repair potential leak locations in accordance with these Specifications and as approved by the Engineer.
4. Backfill excavations to the top of the structure foundation. Do not place backfill against water-bearing walls or over footings unless approved in advance by the Engineer.
    a. If requesting backfilling of walls before testing, include a description of methods that will be used to detect leakage in the backfilled areas.
    b. Engineer's approval of backfilling before testing shall not relieve the Contractor of the responsibility to conduct leakage tests, to satisfy the leakage acceptance criteria for the structure, or to repair leaking portions of the structure, including those portions below or behind the backfill.
5. See Drawings and Section 31_00_00 - Earthwork for requirements to provide wall stability before backfilling.

G. Inlets to/outlets from the structure:
1. Make inlets to and outlets from the structure watertight.
    a. Include valves; stop, sluice, and slide gates; and temporary bulkheads as required.
    b. Inlets and outlets not required to be operable may be temporarily sealed before testing of the compartments to which they open.
    c. Secure inlets used to fill the structure for testing to ensure that no water is entering or leaving the structure once it has been filled to the test level.
2. Adjustments to measured leakage at inlets and outlets based on the manufacturer's or Contractor's estimates will not be allowed.
    a. May be permitted by the Engineer, and, at his/her discretion, only when the Contractor makes specific measurements of leakage at each individual inlet and outlet using methods approved by the Engineer.

3.04 HYDROSTATIC LEAKAGE TEST FOR OPEN OR COVERED CONTAINMENT STRUCTURES ("HST-100")

A. Isolate sections of water-holding structures that can be isolated in actual operation. Fill and test sections for leakage separately.
   1. Fill structures and sections of structures scheduled for testing to 1 inch below any fixed overflow level in covered structures.

B. Initial rate for filling of structures shall not exceed 4 feet per hour.

C. HST-100 testing includes 2 parts, "Qualitative Testing," and "Quantitative Testing," as described in the following paragraphs:
   1. HST-100, Part 1 - Qualitative Testing:
      a. During the first 24 hours after structures are filled, examine exposed concrete surfaces for damp spots or flowing water.
         1) Make observations in early morning, at midday, and in late afternoon.
         2) Continue observations through the duration of the Quantitative Testing period.
         3) Pay particular attention to conditions at joints, honeycombed areas, cracks, and repaired portions of the structure.
      b. Evaluation criteria:
         1) Structure shall be considered to have failed these Qualitative Testing requirements if any of the following conditions are observed.
            a) Water droplets or moist areas on an outside surface that could only have originated inside the structure.
            b) Water is flowing or seeping from joints, cracks, or surfaces.
               (1) Exception: Dampness or wetness on top of a footing, in the absence of flowing water, shall not be considered as failure to meet this criterion.
            c) Moisture can be transferred to a dry hand from the outside surfaces of the filled area.
      c. Repairs and retesting:
         1) Where damp spots or flowing water as described in the preceding paragraphs are observed, mark locations, provide repairs, and retest the structure as specified in subsequent paragraphs.
   2. HST-100 - Part 2: Quantitative Testing:
      a. If approved by the Engineer, Quantitative Testing may begin before repairs are made to areas failing Part 1 of this test; however:
         1) Adjustments to volume loss calculations of Quantitative Testing based on observed leakage will not be permitted.
         2) Defects identified for repair during Qualitative Testing shall be repaired to the satisfaction of the Engineer before approval of the structure.
      b. Report the results of quantitative testing.
         1) Submit completed Attachment A - Leakage Test Report or at a minimum, include the information specified in Attachment A - Leakage Test Report.
      c. Unlined concrete structures:
         1) Fill to the designated water surface elevation. Maintain that level for at least 72 hours before recording initial water levels for leakage test.

2) Duration of test:
   a) Theoretical time required to lower the water surface in the structure by 3/8 inch when leakage is occurring at the maximum allowable rate specified in subsequent paragraphs of this Section.
   b) Duration ("D") of the test in days is determined by the following equation:

$$D = \frac{0.375 \text{ inches}}{(0.0005 \text{ in/in/day} \times H \text{ ft} \times 12 \text{ in/ft})}$$

Where: H = maximum liquid depth

(1) Round results upward to the next full 24-hour period (day).
(2) Minimum duration of test: 24 hours (1 day).
(3) Maximum duration of test: 120 hours (5 days).]

3) Duration of test:
   a) Area 440 structure: 72 hours (3 days).

d. Lined concrete structures and secondary containment areas:
   1) Fill to the designated water surface elevation. Recording of water levels for leakage tests may begin as soon as the designated water surface level is reached and the water surface is calm.
   2) Duration of test: 72 hours (3 days).

e. Measurements: Water level:
   1) Record water levels at 24-hour intervals for the full duration of the test period.
   2) Measure water levels at not less than 2 locations on opposite ends of the structure and preferably at 4 locations spaced equally around the structure. Mark locations on the structure and take measurements at the same locations throughout the duration of the test.
   3) Measure, to an accuracy of 1/16 inch, the vertical distance to the water surface from a fixed point on the structure above.

f. Measurements: Temperatures:
   1) As part of the first and last sets of level measurements, record water temperature at a depth of 18 inches below the water surface. Measure temperature at the same locations where level measurements are taken.
   2) Record ambient temperature at the time of each water level measurement.

g. Measurements: Evaporation and precipitation:
   1) Measure evaporation and precipitation by floating pans inside the structures during testing.
      a) For uncovered structures, measure both evaporation and precipitation.
      b) For covered structures that are well ventilated, measure evaporation.
   2) Measure using specially constructed clear containers:
      a) Provide clear plastic, calibrated, open-top containers not less than 18 inches in diameter and 18-inches deep.

b) Partially fill containers with water and float inside the structure. Make provisions to hold containers in place at each measurement location, but away from structure walls and items passing overhead, such as beams or pipes.
c) Measure initial depth of water in each device. Measure changes in water level in each device at the same time measurements of the water level inside the structure are taken.

h. Restart of test:
1) Engineer may order a restart of the test when, in the Engineer's opinion, measurements have become unreliable due to unusual precipitation or other factors.
2) If measurements or observed leakage during the testing period indicate that the allowable leakage requirements will be exceeded, the test may be terminated before completion of the full test period. Take appropriate actions to correct problems before restarting the test.

i. Calculations of leakage test results:
1) For each section of the structure tested, use water surface level records to calculate average loss of volume per 24-hour interval.
a) For each 24-hour interval during the test, calculate the average of all measured drops in water level around the structure.
b) Use the average drop thus determined to calculate an average loss of volume for each 24-hour interval.
2) Adjustments to leakage calculations:
a) For uncovered basins, calculations shall be corrected for precipitation added to the structure.
b) Calculations may be corrected for evaporation and water temperature.

j. Evaluation criteria:
1) Unless otherwise specified, the average loss of volume during any 24-hour interval shall not exceed the limits shown in Table A.

Table A - Loss of Volume Criteria for Leakage Tests

Structure Type	Maximum Loss of Water Volume
Structure fully lined prior to leakage test.	No measurable loss over 72-hour test period.
Secondary containment areas.	
Structure with monolithically placed membrane floor slab.	0.0125 percent of volume per 24-hour period.
Concrete paved canals, drying beds, lagoons, and similar structures.	0.100 percent of volume per 24-hour period.
Other containment structures.	0.050 percent of volume per 24-hour period.

k. Repairs and retesting:
    1) Structures and portions of structures that have satisfied the qualitative requirements of HST-100 but have failed to satisfy the quantitative requirements of HST-100 may be immediately retested for volume loss.
        a) If the structure fails the second test for volume loss, the structure shall be drained and the Contractor shall observe the interior for probable areas of leakage.
        b) Structure shall not be retested until repairs to the probable areas of leakage are complete.

3.05 REPAIRS FOR RETESTING

A. Locations showing damp spots or flowing water:
    1. Mark locations of visible leaks and damp spots.
    2. Drain structures for repair.
    3. Repair defects causing damp spots and flowing water using methods specified in Section 03_30_00 - Cast-in-Place Concrete and approved by the Engineer.
        a. Repair both interior and exterior surfaces and make structures watertight.
        b. Submit proposed repair products and procedures for Engineer's review.
        c. Refill structures for retesting.
    4. Repeat filling, observations, and repairs until no leaks or damp spots appear.

B. Structures for which water volume loss exceeds the limits specified after adjustments for evaporation, and precipitation:
    1. Determine cause of volume loss.
    2. Drain structures of water.
    3. Repair defects causing loss of water volume using methods specified in Section 03_30_00 - Cast-in-Place Concrete and approved by the Engineer.
        a. Submit proposed repair products and procedures for Engineer's review.
    4. Refill water-holding structures.
    5. Repeat testing and repairs until volume loss does not exceed specified limits.

END OF SECTION

ATTACHMENT A - LEAKAGE TEST REPORT
LEAKAGE TEST REPORT

PROJECT:		SUBMITTED BY:	
STRUCTURE:		WITNESSED BY:	
AREA:		TEST DATES:	
TEST DURATION:		TEST DURATION:	

Surface area of structure tested:		(square feet)
Volume of structure tested:		(cubic feet)
Volume of structure tested:		(gallons)
Measured loss through gates, etc.:		(gallons / day)
Allowable loss of water volume:		(per day)
Allowable loss of water volume:		(% in 24 hours)
Allowable measured loss over test duration (inches):		
Measured loss of water:		(gallons / day - From E below)
Measured loss of water volume (%):		(in 24 hours - From E below)

Water Temperature: Start of test: °F End of test: °F

			Water Surface Elevation (top of structure to top of water)				
			Location #1	Location #2	Location #3	Location #4	Initials**
Day	Date	Time	(inches)	(inches)	(inches)	(inches)	
1							
2							
3							
4							
5							
Changes in Level:							

A. Average change in level (feet): _____ (Average of total charges for all locations)

B. Correction for precipitation: _____ (Measured from pan)

C. Correction for evaporation: _____ (Measured from pan)

D. Corrected change in level (CL): _____

E. Total days tested: _____

F. Average measured % water loss in 24 hours: _____ = $\frac{\text{(CL) x (surface area) x 100}}{\text{(initial water volume) x (number of test days)}}$

Notes and field observations**

**Place date and initials at the beginning of each entry.

SECTION 01_77_00

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Contract closeout requirements.

1.02 REFERENCES

A. American Water Works Association (AWWA).

1.03 FINAL CLEANING

A. Perform final cleaning prior to inspections for Final Completion.

B. Employ skilled workers who are experienced in cleaning operations.

C. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

D. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

E. Clean roofs, gutters, downspouts, and drainage systems.

F. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
   1. Police yards and grounds to keep clean.

G. Remove dust, cobwebs, and traces of insects and dirt.

H. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

I. Remove non-permanent protection and labels.

J. Polish waxed woodwork and finish hardware.

K. Wash tile.

L. Wax and buff hard floors, as applicable.

M. Wash and polish glass, inside and outside.

N. Wash and shine mirrors.

O. Polish glossy surfaces to clear shine.

P. Vacuum carpeted and soft surfaces.

Q. Clean permanent filters and replace disposable filters when heating, ventilation, and air conditioning units were operated during construction.

R. Clean ducts, blowers, and coils when units were operated without filters during construction.

S. Clean light fixtures and replace burned-out or dim lamps.

T. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

1.04 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
   1. Prior to making disposal on private property, obtain written permission from the Owner of such property.

B. Do not fill ditches, washes, or drainage ways which may create drainage problems.

C. Do not create unsightly or unsanitary nuisances during disposal operations.

D. Maintain disposal site in safe condition and good appearance.

E. Complete leveling and cleanup prior to final completion of the Work.

1.05 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Final Completion.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.06 FINAL CLEANING OF PLANT FACILITIES

A. Clean channels, pipe, basins, reservoirs, and tanks before running of 7-day test, or before facility goes online when 7-day test is not required.

B. Wash, wherever practicable, or broom sweep channels, pipe, basins, reservoirs, and tanks.

1.07 FINAL CLEANING AND DISINFECTION OF SYSTEMS OF POTABLE WATER (1W) MAINS

A. Clean interior of pipe and fittings.

B. When pipe contains dirt that cannot be removed by flushing, swab pipe interiors with solution containing not less than 500 parts per million of chlorine until clean.

C. Flush 12-inch diameter and smaller pipe as thoroughly as available water sources will permit.

D. Fill pipe with chlorine solution of sufficient strength to provide 10 parts per million chlorine residual at end of 24 hours.

E. Flush pipes with potable water until chlorine residual is less than 0.6 parts per million before pipes are put into service.

1.08 CLOSEOUT DOCUMENTS

A. Submit the following before Substantial Completion:
   1. Punch list of items to be completed or corrected with the request for issuance of Substantial Completion.
   2. Evidence of Compliance with Requirements of Governing Authorities.
   3. Project Record Documents.
   4. Approved Operation and Maintenance Manuals.
   5. Approved Warranties and Bonds.
   6. Keys and Keying Schedule.
   7. Completed Contract requirements for Commissioning and process Start-Up.

B. Submit the following before final completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Punch list items have been completed and the Engineer and Owner are satisfied that all deficiencies are corrected.
   2. Evidence of Payment and Release of Liens or Stop Payment Notices as outlined in Conditions of the Contract.
   3. Release of claims as outlined in Conditions of the Contract.
   4. Submit certification of insurance for products and completed operations, as specified in the General Conditions.
   5. Final statement of accounting.
   6. Submit Final (As-Built) Schedule as specified in Section 01_32_21 - Schedules and Reports.

1.09 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES

A. Submit the following:
   1. Certificate of Occupancy.
   2. Certificates of Inspection.

1.10 PROJECT RECORD DOCUMENTS

A. Maintain at the Project Site, available to the Owner and Engineer, 1 copy of the Contract Documents, Shop Drawings, and other Submittals in good order:
   1. Mark and record field changes and detailed information contained in Submittals and Change Orders.
   2. Record actual depths, horizontal and vertical location of underground pipes, duct banks, and other buried utilities. Reference dimensions to permanent surface features.
   3. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.

4. Identify location of spare conduits including beginning, ending, and routing through pull boxes and manholes. Record spare conductors, including number and size, within spare conduits and filled conduits.
5. Provide schedules, lists, layout drawings, and wiring diagrams.
6. Make annotations in electronic format. in accordance with the following color code:

Additions:	Red
Deletions:	Green
Comments	Blue
Dimensions:	Grey

B. Maintain documents separate from those used for construction:
1. Label documents “RECORD DOCUMENTS.”

C. Keep documents current:
1. Record required information at the time the material and equipment is installed and before permanently concealing.
2. Engineer will review Record Documents weekly to ascertain that changes have been recorded.

D. Affix civil engineer’s or professional land surveyor’s signature and registration number to Record Drawings to certify accuracy of information shown.

E. Deliver Record Documents with transmittal letter containing date, Project title, Contractor’s name and address, list of documents, and signature of the Contractor.

F. Record Documents will be reviewed monthly to determine the percent complete for the monthly pay application.

G. Updated Record Documents are a condition for the Engineer’s recommendation for progress payment.

H. Final Schedule Submittal as specified in Section 01_32_21 - Schedules and Reports.

1.11 MAINTENANCE SERVICE

A. As specified in Technical Specifications.

1.12 SUBSTANTIAL COMPLETION

A. Obtain Certificate of Substantial Completion.

1.13 FINAL COMPLETION

A. When Contractor considers the Work is complete, submit written certification that:
1. Work has been completed in accordance with the Contract Documents.
2. Punch list items have been completed or corrected.
3. Work is ready for final inspection.

B. Engineer will make an inspection to verify the status of completion with reasonable promptness.

C. Should the Engineer consider that the Work is incomplete or defective:
   1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective Work.
   2. Contractor shall take immediate steps to remedy the stated deficiencies and send a second written certification to the Engineer that the Work is complete.
   3. Engineer shall re-inspect the Work.

1.14 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer at least 7 days prior to final Application for Payment.

B. Statement shall reflect all adjustments to the Contract amount.
   1. The original Contract amount.
   2. Additions and deductions resulting from:
      a. Change Orders.
      b. Units installed and unit prices.
      c. Set-offs for uncorrected or incomplete Work.
      d. Set-offs for liquidated damages.
      e. Set-offs for reinspection payments.
      f. Extended engineering and/or inspection services and inspection overtime.
      g. Excessive Shop Drawings review cost by the Engineer.
      h. Other adjustments.
   3. Total Contract amount, as adjusted.
   4. Previous payments.
   5. Remaining payment due.

C. Engineer will prepare a final Change Order reflecting approved adjustments to the Contract amount which were not previously made by Change Orders.

1.15 FINAL APPLICATION FOR PAYMENT

A. Submit the final Application for Payment reflecting the agreed upon information provided in the final statement of accounting.

PART 2 PRODUCTS

2.01 SPARE PARTS

A. Deliver spare parts as specified in Section 01_60_00 - Product Requirements.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_78_24

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Preparation and submittal of manual with requirements to operate and maintain the equipment.

1.02 PREPARATION

A. General requirements:
   1. Provide dimensions in English units.
   2. Assemble material, where possible, in the same order within each volume.
   3. Reduce drawings and diagrams to 8 1/2 by 11-inch size, if possible unless otherwise specified.
   4. Complete forms on computer, handwriting not acceptable.
   5. Delete items or options not provided in the supplied equipment or system.
   6. Provide package control system annotated ladder logic for PLC, if applicable.

B. Hard copy requirements:
   1. Binders: 3-ring with rigid covers.
      a. Break into separate binders as needed to accommodate large size.
   2. Utilize numbered tab sheets to organize information.
   3. Provide original and clear text on reproducible non-colored paper, 8 1/2 by 11-inch size, 24 pound paper.
   4. Drawings larger than 8 1/2 by 11 inch:
      a. Fold drawings separately and place in envelope bound into the manual.
      b. Label each drawing envelope on the outside regarding contents.

C. Electronic requirements:
   1. File format:
      a. Entire manual in PDF format.
         1) Include text and drawing information.
         2) Provide a single PDF file even if the hard copy version is broken into separate binders due to being large.
         3) Create PDF from the native format of the document (Microsoft Word, graphics programs, drawing programs, etc.).
            a) If material is not available in native format and only available in paper format, remove smudges, fingerprints, and other extraneous marks before scanning to PDF format.
            b) Hard copy record drawing requirements:
               (1) Provide a single multipage PDF file of each set of the scanned drawings.
               (2) Page 1 shall be the cover of the drawing set.

c) At file opening, display the entire cover.
(1) Scan drawings at 200 to 300 dots per inch (DPI), black and white, Group IV Compression, unless otherwise specified.
(2) Scan drawings with photos in the background at 400 dots per inch (DPI), black and white, Group IV Compression.
4) Pagination and appearance to match hard copy.
5) Searchable.
6) Scanned images are not acceptable.
7) Bookmarks:
a) Bookmarks shall match the table of contents.
b) Bookmark each section (tab) and heading.
c) Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
d) At file opening, display all levels of bookmarks as expanded.
8) Thumbnails optimized for fast web viewing.
b. Drawing requirements:
1) Provide additional copy of drawings in most current version of AutoCAD format.
2) Drawings shall have a white background.
3) Drawing shapes shall not degrade when closely zoomed.
4) Screening effects intended to de-emphasize detail in a drawing must be preserved.
5) Delete items or options not provided in the supplied equipment or system.
2. Media:
a. USB flash drive.
b. Secure File Transfer Protocol (SFTP).
3. Label media with the following information:
a. Operation and Maintenance Manual.
b. Equipment name.
c. Specification Section Number
d. Equipment tag number.
e. Owner's name.
f. Project number and name.
g. Date.
4. If multiple submittals are made together, each submittal must have its own subdirectory that is named and numbered based on the submittal number.

1.03 CONTENTS

A. Table of Contents: General description of information provided within each tab section.

B. Complete Attachment A - Equipment Summary Form.

C. Description of system and components.

D. Description of equipment function, normal operating characteristics, and limiting conditions.

E. On-line resources.

F. Telephone resources.

G. Approved submittals.
   1. Markup with any field changes.
   2. Final programming.

H. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.

I. Operating procedures:
   1. Step-by-step instructions including but not limited to the following:
      a. Safety precautions and applicable Safety Data Sheets.
      b. Guidelines.
      c. Other information as needed for safe system operation and maintenance.

J. Preventative maintenance procedures:
   1. Recommended steps and schedules for maintaining equipment.
   2. Troubleshooting.

K. Lubrication information: Required lubricants and lubrication schedules.

L. Overhaul instructions: Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.

M. Manufacturer's technical reference manuals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - EQUIPMENT SUMMARY FORM

EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT TAG NUMBER(S) _____

4. LOCATION OF EQUIPMENT _____

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

_____

_____

_____

6. NAMEPLATE DATA -
   - Horsepower _____
   - Amperage _____
   - Voltage _____
   - Service Factor (S.F.) _____
   - Speed _____
   - ENC Type _____
   - Capacity _____
   - Other _____

7. MANUFACTURER'S LOCAL REPRESENTATIVE

   Name _____

   Address _____

   Telephone Number _____

8. MAINTENANCE REQUIREMENTS:

Maintenance Operation	Frequency	Lubricant (If Applicable)	Comments
(List each operation required. Refer to specific information in Manufacturer's Manual, if applicable)	(List required frequency of each maintenance operation)	(Refer by symbol to lubricant list as required)	

9. LUBRICANT LIST:

Reference Symbol	Conoco Phillips	Exxon/Mobil	BP/Amoco	Other (List)
(Symbols used in Item 7 above)	(List equivalent lubricants, as distributed by each manufacturer for the specific use recommended)			

10. SPARE PARTS (recommendations)_____

_____

11. COMMENTS_____

12. GENERAL INFORMATION:

Date Accepted*: _____

Expected Life*: _____

Project Name & Number: _____

Design Engineer: _____

13. WARRANTY:

Start Date: _____

Expiration Date: _____

Prorated: _____

SECTION 01_78_36

WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Warranty and bonds requirements.

1.02 SUBMITTALS

A. For each item of material or equipment furnished under the Contract:
   1. Submit manufacturer's warranty prior to fabrication and shipment of the item from the manufacturer's facility.
   2. Submit manufacturer's special warranty when specified.

B. Provide consolidated warranties and bonds within 15 calendar days of Substantial Completion.
   1. Contents:
      a. Organize warranty and bond documents:
         1) Include Table of Contents organized by Specification Section number and the name of the product or work item.
      b. Include each required warranty and bond in proper form, with full information, certified by manufacturer as required, and properly executed by Contractor, or subcontractor, supplier, or manufacturer.
      c. Provide name, address, phone number, and point of contact of manufacturer, supplier, and installer, as applicable.
   2. Hardcopy format:
      a. Submit 1 copy.
      b. Assemble in 3 D-side ring binders with durable cover.
      c. Identify each binder on the front and spine with typed or printed title "Warranties and Bonds"; Project Name or Title, and the Name Address and Telephone Number of the Contractor.
   3. Electronic copy in PDF format:
      a. Submit 1 copy.

1.03 OWNER'S RIGHTS

A. Owner reserves the right to reject warranties.

B. Owner reserves the right to refuse to accept Work for the project if the required warranties have not been provided.

1.04 RELATIONSHIP TO GENERAL WARRANTY AND CORRECTION PERIOD

A. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, both Contractor's general warranty and the correction period requirements.

B. Disclaimers and limitations in specific materials and equipment warranties do not limit Contractor’s general warranty, nor does such affect or limit Contractor’s performance obligations under the correction period.

1.05 MANUFACTURER’S 1 YEAR WARRANTY MINIMUM REQUIREMENTS

A. Written warranty issued by item’s manufacturer.

B. Project-specific information, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Contractor.

C. Covers all costs associated with the correction of the defect, including, but not limited to, removal of defective parts, new parts, labor, and shipping.

D. Provides a timely response to correct the defect.
   1. Manufacturer shall provide, in a timely fashion, temporary equipment as necessary to replace warranted items requiring repair or replacement, when warranted items are in use and are critical to the treatment process, as defined by Owner.

E. Warranty commence running on the date of substantial completion.
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of warranty period.

F. Duration of warranty: 1 year.

1.06 MANUFACTURER’S SPECIAL WARRANTY

A. Manufacturer’s special warranty is a written warranty published by the manufacturer which includes the requirements as specified in the Technical Section.
   1. Project-specific information and requirements.
   2. Properly executed by product manufacturer.
   3. Expressly states that its provisions are for the benefit of the Contractor or Owner.
   4. Manufacturer’s special warranties commence on the date that the associated item is certified by Engineer as substantially complete.

1.07 WARRANTY WORK

A. Contractor’s responsibilities:
   1. Manufacturer’s disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the work that incorporates the product, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with Contractor.

B. Replacement cost:
   1. Upon determination that work covered by warranty has failed, replace or rebuild the work to an acceptable condition complying with requirement of the Contract Documents.
      a. Contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether Owner has benefited from the use of the work through a portion of its anticipated useful service life.

C. Related damages and losses:
   1. When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.

D. Owner's recourse:
   1. Written warranties are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitation on time in which Owner can enforce such other duties, obligations, rights, or remedies.

E. Reinstatement of warranty:
   1. When work covered by a warranty has failed and has been corrected by replacement or rebuilding, reinstate the warranty by written endorsement.
      a. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

1.08 IMPLIED WARRANTIES

A. Warranty of title and intellectual rights:
   1. Except as may be otherwise indicated in the Contract Documents, implied warranty of title required by Laws and Regulations is applicable to the Work and to materials and equipment incorporated therein.
   2. Provisions on intellectual rights, including patent fees and royalties, are in the General Conditions, as may be modified by the Supplementary Conditions.

B. Implied warranties: Duration in accordance with Laws and Regulations.

1.09 BONDS

A. Equipment bond and other bond requirements as specified in the Technical Sections.

B. Bonds commence running on the date of substantial completion.
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of bond period.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_81_50

DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design criteria for use in the selection of equipment and appurtenances specified in Technical Sections of these Specifications and indicated on the Drawings.
   2. Criteria for design of systems, components and equipment fabricated off site and shipped to the Work for installation.
   3. Criteria for design of anchors to connect equipment and appurtenances to supports and structures.

B. The criteria in this Section apply throughout the Work, unless additional criteria, or more restrictive criteria, are indicated.
   1. Additional criteria and requirements relevant to specific locations, specific materials, and specific equipment are indicated on the Drawings, and in the Technical Sections.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 7-16 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures. (ASCE 7).

B. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
   1. ASHRAE Fundamentals Handbook.

C. International Code Council (ICC):
   1. International Energy Conservation Code (IECC).
   2. International Plumbing Code (IPC).

D. Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA):
   1. Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd edition 2008.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA - SITE INFORMATION

A. Site name: Post Point Wastewater Treatment Plant.
   1. Street address: As specified in Section 01_11_00 - Summary of Work.
      a. Coordinates (approximate):
         1) Latitude 48.71877065790119.
         2) Longitude -122.51443106791628.

2. Site elevation (approximate):
    a. 18 feet above mean sea level.
3. Groundwater elevation:
    a. See Project geotechnical reports, listed in Document 00_73_00 - Supplementary Conditions.
    b. For design of buried and partially buried construction:
        1) Assume groundwater level approximately 5 feet below finished grade.

2.02 DESIGN CRITERIA - REGULATORY REQUIREMENTS

A. Requirements of authorities having jurisdiction over the Project are included in Section 01_41_00 - Regulatory Requirements.

2.03 DESIGN CRITERIA - OPERATING ENVIRONMENT

A. Drawings and Technical Sections include additional criteria and requirements relevant to specific locations, materials, and equipment.

B. Outdoor conditions:
1. IECC: Climate Zone 4C.
2. ASHRAE site climatic data location: Bellingham, WA, USA. WMO: 727976
3. Temperature criteria: As specified in the following Table: Design Temperatures - Outdoor Criteria in Accordance with 2025 ASHRAE Fundamentals Handbook.

Table: Design Temperatures - Outdoor Criteria in Accordance with ASHRAE Fundamentals Handbook

Condition	Criteria
Extreme Annual Temp:	Basis of design 50-year data: 99.1 degrees Fahrenheit dry-bulb.
Winter:	At or above this temperature 99.6 percent of the time: 20.4 degrees Fahrenheit dry-bulb.
Summer:	At or above this temperature 0.4 percent of the time: 80.7 degrees Fahrenheit dry-bulb.

4. Rainfall intensity:
    a. Reference: International Plumbing Code (IPC):
        1) 1 inches per hour (100-year, 1-hour rainfall).

C. Indoor conditions:
1. HVAC:
    a. As specified in Section 23_09_13 - Instrumentation and Control Devices for HVAC.

2.04 DESIGN CRITERIA - STRUCTURAL

A. General:
1. Criteria for structural design of:
    a. Equipment at locations subject to seismic events.
    b. Equipment exposed to outdoor environments.

c. Equipment supports and bracing, and anchorage of such items to building and non-building structures.
d. Structures provided for the Work through Delegated Design.
e. Manufactured and prefabricated structures, and anchorage of such structures to foundations or other supporting elements.

2. Structural design criteria used by the Engineer of record and required by the building code to be indicated on the Drawings are included on the Contract Drawing titled “General Structural Notes.”

B. Delegated Design:
1. As specified in Section 01_35_73 - Delegated Design Procedures.
2. Structural engineering design shall be performed by a Professional or Structural Engineer licensed in the State of Washington.

C. Structure risk category:
1. Develop design loads and provide detailing in accordance with the provisions of ASCE 7 and the building code specified in Section 01_41_00 - Regulatory Requirements, based on the Structure Risk Category indicated in Table: Project Structures - Risk Category and Seismic Design Information.

D. Seismic loads:
1. Seismic design parameters: Basic parameters - ASCE 7:
a. Ground motion MCE_R, 5 percent damped:
1) Short periods, Ss = 1.018 g.
2) 1 second period, S_1 = 0.358 g.
b. Peak ground acceleration, MCE_G:
1) Peak ground acceleration, PGA = 0.507 g.
c. Mapped long-period transition period:
1) TL = 16 seconds.
2. Structures - General:
a. Seismic Design Category (SDC): As indicated in the following Table: Project Structures - Risk Category and Seismic Design Information.

Table: Project Structures - Risk Category and Seismic Design Information

Description: Wastewater Treatment Facility

Area	Description	Risk Category	Site Class	S_{DS}	S_{D1}	Seismic Design Category(1)
All	All Structures	III	D	0.742	0.463	D

Notes:
(1) Seismic Design Category for Delegated Design, and for seismic certification of electrical and mechanical equipment as required by ASCE 7.

b. Structure response modification coefficient, R:
1) In accordance with ASCE 7 and the requirements of the Technical Sections.
3. Structures - Tanks and vessels.
a. Includes: Tank structures, tank supports, and anchorage to structures or foundations.

b. Liquid storage structures (e.g., basins and tanks).
   1) Include impulsive and convective ("sloshing") effects.
   2) Component response modification factor - impulsive effects, Ri: In accordance with ASCE 7, Table 15.4-2.
   3) Component response modification factor - convective effects, Rc = 1.0.
c. Dry material storage structures (e.g., silos, hoppers):
   1) Include effects of stored materials.
   2) Component response modification factor - impulsive effects, Ri: In accordance with ASCE 7, Table 15.4-2.

4. Non-structural components - General:
   a. Includes:
      1) Mechanical and electrical equipment; anchorage of equipment to structures or supports; design of supports; and anchorage of supports to structures or foundations.
      2) Distribution systems associated with mechanical and electrical equipment such as piping, ductwork, conduits, cable trays, raceways, bus ducts, and similar items; anchorage of such systems to supports and structures; and bracing or such systems.
   b. Seismic design requirements for non-structural components are based on the Seismic Design Category (SDC) of the structure or facility where the equipment is installed.
   c. Design components, component anchorage, and component connections to piping and utilities in accordance with the requirements of ASCE 7, Table 13.2-1.
   d. Component amplification factor (ap), response factor (Rp), and overstrength factor for anchorage to concrete (Ωo):
      1) Mechanical and electrical components and systems: In accordance with ASCE 7, Table 13.6-1, unless otherwise indicated in the Technical Sections for these items.
      2) Architectural components and systems: In accordance with ASCE 7, Table 13.6-1, unless otherwise indicated in the Technical Sections for these items.
   e. Component importance factor, I_p:
      1) In accordance with the following Table: Component Importance Factor for Seismic Design, I_p.
      2) For items not listed in Table: Component Importance Factor for Seismic Design, I_p, designate importance factor in accordance with the provisions of ASCE 7, Chapter 13, and submit to the Engineer for review prior to developing calculations and details related to that component.

Table: Component Importance Factor for Seismic Design, I_p

Structure Seismic Design Category	Components	I_p
All	Electrical: Items and distribution system components specified in Division 26 - Electrical.	1.5
All	Process Control and Instrumentation Systems: Components and distribution systems specified in Division 40 - Process Integration.	1.5

Table: Component Importance Factor for Seismic Design, I_p		
Structure Seismic Design Category	**Components**	**I_p**
All	Conveyance and distribution systems and supports for toxic, highly toxic, hazardous, or explosive substances as specified in Divisions 06 through 49.	1.5
All	Conveying equipment: Items specified in Division 14	1.5
All	Equipment and components specified in Divisions 11 through 49, except HVAC and plumbing components listed below.	1.5
All	Plumbing equipment specified in the following Sections: 22_42_01 - Plumbing Systems	1.0
All	HVAC equipment specified in the following Sections: 23_81_44 - Heat Pumps 23_83_01 - Heating Units 23_34_01 - Fans 46_78_83 - Packaged Biotrickling Filter Odor Control System (Fans)	1.0
All	Other equipment not listed above.	1.0

5. Non-structural components: HVAC ductwork.
    a. Component importance factor, I_p: Determine in accordance with ASCE 7, Section 15.4.1.1.
    b. Seismic design category:
        1) See Table: Component Importance Factor for Seismic Design, I_p (preceding).

E. Wind loads:
1. Design structures and non-structural components that are exposed to wind to withstand design wind loads.
    a. Reduction of wind loads based on shielding effects of surrounding structures or components is not allowed.
    b. Design for wind loading is not required for non-structural components and for non-building structures located inside enclosed buildings.
2. Design parameters:
    a. Basic wind speed:
        1) 105 miles per hour (33 feet, 3 second gust).
    b. Exposure category: C.
    c. Topographic factor, Kzt: 1.0.
    d. Wind pressure for design of “components and cladding”.
        1) “Components and cladding” includes doors, windows, siding panels, skylights, parapets and similar architectural elements.
        2) Minimum wind pressure for components and cladding, strength level:
            a) Wall elements: Minimum 30 pounds per square foot, pressure or vacuum.
            b) Roof elements: Minimum 74 pounds per square foot, pressure or vacuum.
            c) For “allowable stress level” pressures, multiply strength level pressures by 0.625.

F. Snow loads:
   1. Design for snow loading is not required for non-structural components and for non-building structures located inside enclosed buildings.
   2. Design parameters:
      a. Ground snow load: pg = 15 pounds per square foot.
      b. Flat roof snow load: pf = 12 pounds per square foot, minimum.
      c. Exposure factor, minimum: Ce = 1.0.
      d. Importance factor, minimum: Is = 1.1.
      e. Drifting:
         1) Consider effects of adjacent and nearby structures and equipment on drift loads.
   3. Ice build-up at eaves:
      a. Minimum 100 pounds per linear foot along lower edges of roof.

G. Atmospheric icing design criteria ASCE 7, Chapter 10:
   1. Nominal ice thickness due to rain (33-foot height): 1 inches.

H. Rainfall loads:
   1. Determine rainfall loads using rainfall intensity specified in this Section, and including effects of exposed surface slope, height above surface to discharge elevation, and deflection of ponded surfaces.

I. Operational loads:
   1. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), surge or “water hammer,” and other load conditions.
   2. Design for loads indicated by the equipment manufacturer.
   3. Design for loads indicated in the Technical Sections for equipment and appurtenances.

J. Serviceability considerations:
   1. Deflection, unless otherwise indicated on the Drawings, or specified:
      a. Beam deflection as fraction of span:
         1) Walkways and platforms: Total load = L/240; live load = L/360.
         2) Equipment supports: L/450.

PART 3 EXECUTION

3.01 GENERAL

A. Design approach and criteria in accordance with:
   1. Regulatory requirements, including but not limited to the building code specified in Section 01_41_00 - Regulatory Requirements.
   2. Reference standards and project-specific design criteria listed in this Section.
   3. Specific requirements for individual elements and components of the Work as specified in subsequent Technical Sections.

B. In the event of conflicts between design criteria, contact Engineer for interpretation.

C. Where Owner-Delegated Design is required by the Specifications, prepare and submit designs as specified in Section 01_35_73 - Delegated Design Procedures.

3.02 DELEGATED DESIGN

A. Where Delegated Design is required by the Technical Sections, prepare and submit designs as specified in Section 01_35_73 - Delegated Design Procedures.

B. Calculations:
   1. Where submittal of calculations is required:
      a. Provide complete calculations, including sketches to illustrate the design concepts being evaluated, and details to fully describe proposed construction.
   2. Requirements for seismic design calculations will be waived for the following:
      a. Furniture and storage racks 6 feet in height or less.
      b. Moveable equipment.
      c. Mechanical and electrical equipment and components located in structures designated as Seismic Design Category A or B.
      d. Mechanical and electrical equipment and components located in structures designated as Seismic Design Category C and where the component importance factor, I_p, is equal to 1.0.
   3. Requirements for wind design calculations will be waived for the following:
      a. Equipment and components located inside structures, and away from the effects of wind loads.

C. Shop Drawings:
   1. Describing components and manufacturer's requirements for connections.
      a. Include details for connections of components to structures and supports.
      b. Include details for anchoring bracing to structures where required.

3.03 DESIGN - ANCHORS FOR EQUIPMENT, COMPONENTS, AND BRACING

A. General:
   1. Engineer's approval of anchor designs is required before placement of construction that supports or provides bracing for anchored equipment and components.
      a. Prepare anchor designs after Engineer's approval of the products and layout, and before placement of concrete or masonry that supports them.
   2. Adjust equipment pad sizes and add additional anchor confinement reinforcing to provide required strength at anchorage points between equipment and pad, and between pad and structure.
   3. Supports and bracing:
      a. Design and install braces and anchors to transfer forces from equipment and components to the lateral force resisting system of the surrounding structure.
      b. Anchor and brace piping, ductwork, and electrical distribution components so that lateral or vertical displacement does not result in damage to or failure of essential architectural, mechanical, or electrical equipment.
         1) Provide supplementary framing where required to transfer forces.
         2) Detail and locate braces and anchors to minimize differential movements between components and structure.

B. Preparation:
    1. Obtain manufacturer's information:
        a. Weight and dimensions of components.
        b. Layout and location of anchors that connect to equipment base plates, sole plates, skids, or pads.
        c. Sizes of holes for anchors that will be provided in equipment bases or support frames.

C. Analysis and design:
    1. Perform and submit calculations to determine anchor designs at locations where equipment and equipment supports are connected to the supporting structure.
        a. Indicate number, size, type, and material for anchors.
    2. In determining forces at locations where equipment is anchored to structures, include effects of:
        a. Equipment self-weight and operating weight.
        b. Location of equipment center of mass.
        c. Forces from equipment operation including, but not limited to:
            1) Effects of internal contents including weight and sloshing.
            2) Effects of thrust, surge, and water hammer where specified.
            3) Equipment reactions and operating torque.
            4) Equipment vibration.
            5) Thermal effects from equipment and from distribution systems connected to the equipment (piping, ducts, and electrical).
            6) Other load or displacement inducing conditions.
        d. Forces on equipment from loads specified in this Section.
            1) Include effects of wind, snow, and icing loads where applicable.
            2) Design for load combinations indicated in ASCE 7, unless otherwise specified or indicated on the Drawings.
            3) Seismic and wind loads: For equipment and tanks with weight that varies based on the volume of contained material, determine anchor forces to accommodate the full range of filled, partially filled, and empty conditions.
    3. Determine forces and overturning moments at equipment supports and at locations where supports are anchored to structures.
        a. Indicate shear force and associated axial force at each anchor.
    4. Do not use friction to resist sliding resulting from seismic or wind forces.
        a. Resist sliding only by direct application of sliding loads to fasteners as bearing, shear, tension, or compression forces.
    5. Using combined shears and axial forces at each anchor, design anchors and anchor groups for ductile failure.
        a. Ductile failure: Anchor yield before failure of base material, typically concrete or masonry, at the anchor.
    6. Anchor selection:
        a. Provide anchors type indicated on the Drawings.
        b. Where anchors are not specifically indicated on the Drawings, select in accordance with the following:
            1) Anchors that resist seismic and wind forces:
                a) Cast-in-place forged hex-head anchor bolt.

2) Anchors loaded in sustained tension:
    a) Cast-in-place forged hex-head anchor bolt.
3) Anchors for reciprocating, vibrating, and rotating equipment:
    a) Cast-in-place forged hex-head anchor bolt.

c. Do not use post-installed anchors, mechanical or adhesive, unless:
    1) Post-installed anchors are indicated on the Drawings, or
    2) Post-installed are approved by the Engineer prior to placement of the surrounding concrete or masonry.
d. Anchor diameter:
    1) Select diameter so that hole in base plate is not greater than 125 percent of the nominal diameter of the anchor, nor greater than the diameter of the anchor plus 1/4 inch.

7. Determine number, size, layout, and minimum effective embedment for anchors.
    a. Layout includes anchor spacing and required distance(s) from anchor to edge(s) of supporting concrete or masonry.
    b. Anchors in concrete: Design based on minimum specified 28-day compressive strength, f'c, as follows, unless otherwise indicated on the Drawings for the Work area:
        1) As specified in Section 03_30_00 - Cast-in-Place Concrete.
        2) Existing concrete in place prior to this Work: f'c = 3,000 pounds per square inch.
8. Prepare Drawings showing construction details of anchor designs.
9. Submit design calculations and Drawings prior to placement of anchors, and of the structural elements to which they will connect.

END OF SECTION

SECTION 03_01_01

PREPACKAGED SMALL AGGREGATE REPAIR CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Prepackaged concrete for the repair of concrete.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C33 - Standard Specification for Concrete Aggregates.
   2. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   3. C150 - Standard Specification for Portland Cement.

B. International Concrete Repair Institute (ICRI):
   1. Guideline No. 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

A. Product data.

B. Manufacturer’s instructions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store in unopened containers in clean, dry area with temperature between 45 and 90 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 PREPACKAGED CONCRETE

A. Coarse aggregate: Maximum 3/8-inch aggregate in accordance with ASTM C33.

B. Portland cement: Type I or II in accordance with ASTM C150.

C. Compressive strength: 5,000 pounds per square inch at 28 days minimum, in accordance with ASTM C39.

D. Packaged in multi-wall bags.

E. Manufacturers: One of the following or equal:
   1. Master Builders Solutions/Sika, MasterEmaco S 440.
   2. Sika, Sikacrete 211.

PART 3 EXECUTION

3.01 PREPARATION

A. In accordance with manufacturer's written instructions. If manufacturer's instructions are not available, prepare as indicated:
   1. Clean entire slab surface as required to remove dirt, oil, curing compound, laitance, dust, and other matter that may prevent proper grout bonding.
   2. Concrete substrate shall have rough texture, suitable for bonding repair concrete.
   3. Roughen concrete substrate in contact with repair concrete to ICRI Guideline No. 310.2R, CSP-6 surface profile or rougher using method suitable to the Engineer.
      a. Remove loose or broken concrete.
   4. Saturate concrete substrate with potable water for minimum of 3 days just before placing repair concrete. At time repair concrete is placed, substrate shall be saturated and surface damp with no standing water.

3.02 INSTALLATION

A. Slump range: 4 to 6 inches.

B. Mix in accordance with manufacturer’s instructions.

C. Water for mixing: As specified in Section 03_30_00 - Cast-in-Place Concrete.

D. Water cure concrete repair area as specified in Section 03_30_00 - Cast-in-Place Concrete.

END OF SECTION

SECTION 03_11_07

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Concrete formwork.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.

B. Underwriters Laboratories (UL).

1.03 SUBMITTALS

A. Information on proposed forming system:
   1. Submit in such detail as the Engineer may require to assure themselves that intent of the Specifications can be complied with by use of proposed system.
   2. Alternate combinations of plywood thickness and stud spacing may be submitted.

1.04 QUALITY ASSURANCE

A. Qualifications of formwork manufacturers: Use only forming systems by manufacturers having a minimum of 5 years of experience, except as otherwise specified, or accepted in writing by the Engineer.

B. Regulatory requirements: Install Work of this Section in accordance with local, state, and federal regulations.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
   1. Concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
   2. Forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B. Performance requirements:
   1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.

2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
3. Provide sufficient number of forms so that the Work may be performed rapidly and present uniform appearance in form patterns and finish.
4. Use forms that are clean and free from dirt, concrete, and other debris.
    a. Coat with form release agent if required, prior to use or reuse.

2.02 MANUFACTURED UNITS

A. Forms:
    1. Built-up plywood:
        a. May be substituted for prefabricated forming system, subject to the following minimum requirements:
            1) Size and material:
                a) Use full size 4-foot by 8-foot plywood sheets, except where smaller pieces are able to cover entire area.
                b) Sheet construction: 5-ply plywood sheets, 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.
            2) Wales: Minimum 2-inch by 4-inch lumber.
            3) Studding and wales: No loose knots and free of warps, cups, and bows.
    2. Steel:
        a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.
        b. Capable of providing finish surfaces that are flat without bows, cups, or dents.
    3. Steel-framed plywood:
        a. Provide forms that are rigidly constructed and capable of being braced.
        b. Plywood paneling: 5-ply, 5/8-inch nominal or 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

B. Form release agent.
    1. Effective, non-staining, bond-breaking coating compatible with form surfaces and concrete mixes used.

C. Form ties:
    1. General:
        a. Provide form ties for forming system selected that are manufactured by a recognized manufacturer of concrete forming equipment.
        b. Do not use wire ties or wood spreaders.
        c. Provide ties of type that accurately tie, lock, and spread forms.
        d. Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
        e. Do not allow holes in forms for ties to allow leakage during placement of concrete.

2. Cone-snap ties:
    a. Shall form a cone shaped depression in the concrete with minimum diameter of 1 inch at the surface of the concrete and minimum depth of 1-1/2 inches.
    b. Provide neoprene waterseal washer that is located near the center of the concrete.
3. Taper ties:
    a. Neoprene plugs for taper tie holes: Size so that after they are driven, plugs are located in center third of wall thickness.

D. Incidentals:
1. External angles:
    a. Where not otherwise indicated on the Drawings, provide with 3/4-inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.
    b. Provide 1/4-inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion and construction joints.
2. Keyways: Steel, plastic, or lumber treated with form release agent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Site verification of conditions:
1. Do not place concrete until forms have been checked for alignment, level, and strength, and mechanical and electrical inserts or other embedded items for correct location.

3.02 INSTALLATION

A. Forms:
1. Built-up plywood:
    a. Studding:
        1) Spaced at 16 inches or 24 inches on center.
        2) Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.
        3) Install studs perpendicular to grain of exterior plys of plywood sheets.
    b. Wales: Double lumber material with minimum size as specified in this Section.
    c. Number of form reuses: Depends upon durability of surface coating or overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.
2. Steel:
    a. Adequately brace forms for minimum deflection of finish surface.

3. Steel-framed plywood:
    a. Rigidly construct and brace with joints fitting closely and smoothly.
    b. Number of form reuses: Depends upon durability of surface coating or overlay used.
4. As specified in this Section, built-up plywood forms may be used in conjunction with steel forms or steel-framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

B. Form bracing and alignment:
1. Line and grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.
2. Formwork:
    a. Securely brace, support, tie down, or otherwise hold in place to prevent movement.
    b. Make adequate provisions for uplift pressure, lateral pressure, and deflection of forms.
3. When second lift is placed on hardened concrete, take special precautions in formwork at top of old lift and bottom of new lift to prevent:
    a. Spreading and vertical or horizontal displacement of forms.
    b. Grout “bleeding” on finish concrete surfaces.
4. Pipe stubs, anchor bolts, conduits, and other embedded items:
    a. Set in forms, position, and secure prior to placement of concrete to maintain a minimum 1-1/2-inch clearance between the item and any concrete reinforcement.
    b. Securing embedded items in position by wiring or welding to the reinforcement is not permitted.
5. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16 inch or larger by tightening forms or by filling with acceptable crack filler acceptable to the Engineer.

C. Forming incidentals:
1. Keyways: Construct as indicated on the Drawings.
2. Reentrant angles: May be left square.
3. Level strips: Install at top of wall concrete placements to maintain true line at horizontal construction joints.
4. Inserts:
    a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, in concrete.

D. Form release agent:
1. Apply in accordance with the manufacturer’s instructions.

E. Form ties:
1. Cone-snap ties: Tie forms together at not more than 2-foot centers vertically and horizontally.

3.03 FORM REMOVAL

A. General:
   1. Keep forms in place, as specified in the following paragraphs, to provide curing and to protect concrete surfaces and edges from damage.
   2. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified.

B. Form removal:
   1. Do not remove forms from concrete which has been placed when outside ambient air temperature is below 50 degrees Fahrenheit until the following conditions are satisfied:
      a. Concrete has sufficient strength to allow form removal without damage to surfaces.
      b. At least 48 hours have elapsed since the end of concrete placement.
      c. Provisions are in place to maintain moisture for curing concrete, and temperature at or above the required minimum curing temperature specified.
   2. Vertical forms:
      a. Retain in place for a minimum of 24 hours after concrete is placed.
      b. If concrete has sufficient strength and hardness to resist surface or other damage after 24 hours, forms may be removed.
   3. Other forms supporting concrete, and shoring: Retain in place as follows:
      a. Formed sides of footings: 24 hours minimum.
      b. Formed vertical sides of beams, girders, and similar members: 48 hours minimum.
      c. Forms below slabs, beams, and girders: Until concrete strength reaches specified strength f'c or until shoring is installed.
         1) Shoring for slabs, beams, and girders: Shore until concrete strength reaches minimum specified 28-day compressive strength.

3.04 SURFACE REPAIRS AND FINISHING

A. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified in Section 03_30_00 - Cast-in-Place Concrete.

B. Form ties:
   1. Snap ties:
      a. Break off ties and remove from concrete.
      b. Roughen cone shaped tie holes by heavy sandblasting before repair.
      c. Dry pack cone shaped tie holes with dry-pack mortar as specified in Section 03_60_00 - Grouting.
   2. Taper ties:
      a. Rubber plugs in tie holes:
         1) After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
            a) Heavy sandblast and then clean tie holes.

b) After cleaning, drive neoprene plug into each of taper tie holes with steel rod.
(1) Final location of neoprene plug shall be in center third of wall thickness.
(2) Bond neoprene plug to concrete with epoxy.
c) Locate steel rod in cylindrical recess and against middle of plug during driving.
(1) Do not drive on flat area outside cylindrical recess.

b. Dry-pack of tie holes:
1) After installing plugs in tie holes, coat tie hole surface with epoxy bonding agent and fill with dry-pack mortar as specified in Section 03_60_00 - Grouting.
a) Place dry-pack mortar in holes in layers with thickness not exceeding tie hole diameter and heavily compact each layer.
b) Dry-pack hole on the outside of the face of the wall no sooner than 7 days after hole on the inside of the face of the wall has been dry packed.
c) Wall surfaces in area of dry-packed tie holes: On the water side of water containing structures and the outside of below grade walls:
(1) Cover with minimum of 10 mils of epoxy gel.
(2) Provide epoxy gel coating on wall surfaces that extends a minimum of 2 inches past dry-pack mortar-filled tie holes.
(3) Provide finish surfaces that are free from sand streaks or other voids.

3.05 CONCRETE TOLERANCES

A. Finish concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.

B. Construct Work within the tolerances in accordance with ACI 117, except as modified in the following paragraphs or as indicated on the Drawings.
1. General:
a. At certain locations, tolerances required for equipment placement and operation may be more restrictive than the general tolerance requirements in this Section.
b. Confirm equipment manufacturers' required tolerances for location and operation of equipment that will be installed, and construct concrete to satisfy those requirements.
2. Slabs:
a. Slope: Uniformly sloped to drain when slope is indicated on the Drawings.
b. Slabs indicated to be level: Maximum vertical deviation of 1/8 inch in 10-foot horizontal length without any apparent changes in grade.
3. Circular tank walls:
a. May deviate from finish line indicated on the Drawings by use of forms with chord lengths not to exceed 2 feet.

4. Inserts and embedments:
    a. Set to tolerances required for proper installation and operation of equipment or systems to which insert pertains.
    b. Maximum tolerances as follows:

Item	Tolerance
Sleeves and inserts	Plus 1/8 inch; minus 1/8 inch.
Anchor bolts:	
Projected ends	Plus 1/4 inch; minus 0.0 inch.
Axial alignment	Not more than 2 degrees off the axis indicated on the Drawings.
Setting location	Plus 1/16 inch; minus 1/16 inch.
All embedments	Minimum 1 inch clearance from reinforcing steel.

    c. Securing embedded items in formwork by wiring or welding to reinforcement is not permitted.

C. Remove and replace Work that does not conform to the required tolerances.

END OF SECTION

SECTION 03_15_00

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Waterstops.
   2. Joint fillers.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D570 - Standard Test Method for Water Absorption of Plastics.
   2. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   5. D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
   6. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   7. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   8. D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   9. D2240 - Standard Test Method for Rubber Property - Durometer Hardness.

B. U. S. Army Corps of Engineers (USACE):
   1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.03 SUBMITTALS

A. Product data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.

C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
    1. Certificates of Compliance:
        a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
    2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.04 QUALITY ASSURANCE

A. Mock-ups:
    1. Welding demonstration:
        a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

B. Field joints:
    1. Polyvinyl chloride waterstops field joints: Free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of material to water pressure at any point. Replace defective joints. Remove faulty material from site and disposed of by Contractor at its own expense.

C. Inspections:
    1. Quality of welded joints will be subject to acceptance of Engineer.
    2. Polyvinyl chloride waterstop: Following defects represent partial list that will be grounds for rejection:
        a. Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
        b. Exterior crack at joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
        c. Any combination of offset or crack that will result in net reduction in cross section of waterstop in excess of 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
        d. Misalignment of joint that will result in misalignment of waterstop in excess of 1/2 inch in 10 feet.
        e. Porosity in welded joint as evidenced by visual inspection.
        f. Bubbles or inadequate bonding.

PART 2 PRODUCTS

2.01 JOINT FILLERS

A. General:
    1. Use specific type in applications as indicated on the Drawings.
    2. Do not use scrap or recycled materials to manufacture joint fillers.

B. Preformed expansion joint materials:
   1. Bituminous fiber expansion joint material:
      a. Properties:
         1) Thickness: To match joint width indicated on the Drawings.
         2) Asphalt-impregnated fiber in accordance with ASTM D1751.
      b. Manufacturers: One of the following or equal:
         1) Durajoint.
         2) W.R. Meadows, SealTight Fibre Expansion Joint.
   2. Synthetic sponge rubber expansion joint material:
      a. Properties:
         1) Thickness: As recommended for width indicated on the Drawings.
         2) Material in accordance with ASTM D1752, Type I.
      b. Manufacturers: One of the following or equal:
         1) Williams Products Inc., Everlastic 1300.
         2) W.R. Meadows, SealTight Sponge Rubber.

2.02 WATERSTOPS

A. Waterstops - polyvinyl chloride (PVC):
   1. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements as specified in this Section.
   2. Manufacturers: One of the following or equal:
      a. Vinylex Corp.
      b. Sika Corp., Greenstreak PVC Waterstop.
   3. Type: Ribbed waterstop:
      a. Construction joints: 6-inch wide ribbed type.
      b. Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb.
      c. Expansion joints: 9-inch wide ribbed type with hollow center bulb.
      d. Dumbbell-type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
      e. No scrap or reclaimed material shall be used.
   4. Properties as indicated in the following table:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D792	Not less than 1.3.
Hardness	ASTM D2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D638	Not less than 2,000 pounds per square inch.
Ultimate Elongation	ASTM D638	Not less than 300 percent.
Alkali Extraction	CRD-C-572	Change in weight after 7 days: Between minus 0.1 percent and plus 0.25 percent. Change in hardness after 7 days: Not more than plus 5 points.
Low Temperature Brittle Point	ASTM D746	No sign of cracking or chipping at -35 degrees Fahrenheit.
Water Absorption	ASTM D570	Not more than 0.15 percent after 24 hours.

Physical Characteristics	Test Method	Required Results
Accelerated Extraction Test	CRD-C-572	Tensile strength: Not less than 1,600 pounds per square inch. Elongation: Not less than 280 percent.
Stiffness in Flexure	ASTM D747	Not less than 600 pounds per square inch.
Tear Resistance	ASTM D624	Not less than 225 pounds per inch.
Thickness	-	3/8 inch.
Center Bulb		
6-inch Waterstops	-	7/8 inch or 1-inch nominal outside diameter.
9-inch Waterstops	-	For expansion joints 1 inch and narrower: 1-inch nominal outside diameter. For expansion joints wider than 1 inch: 2-inch nominal outside diameter.
Allowable Tolerances		
Width	-	Plus or minus 3/16 inch.
Thickness	-	Plus or minus 1/32 inch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops:
   1. General:
      a. Store waterstops so as to permit free circulation of air around waterstop material and prevent direct exposure to sunlight.
      b. Install waterstops in concrete joints where indicated on the Drawings.
      c. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
      d. In waterbearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
      e. Provide waterstops that are continuous.
      f. Set waterstops accurately to position and line as indicated on the Drawings.
      g. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
      h. Position the waterstop so that symmetrical halves of waterstop are equally divided between concrete pours. Center axis of waterstop shall be coincident with centerline of the joint.
      i. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
      j. Use wires at not more than 24 inches on centers near outer edge of waterstop to tie waterstops into position.

k. Special clips may be used in lieu of wires, at Contractor's option.
l. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.
m. When any waterstop is installed in concrete on one side of joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, take suitable precautions to shade and protect exposed waterstop from direct rays of sunlight during entire exposure and until exposed portion is embedded in concrete.
n. When placing concrete at waterstops in slabs, lift edge of waterstop while placing concrete below the waterstop. Manually force waterstop against and into concrete, and then cover waterstop with fresh concrete.

2. Polyvinyl chloride waterstop:
   a. Install waterstops so that joints are watertight.
   b. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
      1) Do not damage material by heat sealing.
      2) Make joints by overlapping, then simultaneously cut ends of sections to be spliced so they will form smooth even joint. Heat cut ends with splicing tool until the plastic melts. Press 2 ends together until plastic cools.
      3) Maintain continuity of waterstop ribs and tubular center axis.
      4) The splices shall have tensile strength of not less than 60 percent of unspliced materials tensile strength.
   c. Butt joints of ends of 2 identical waterstop sections may be made while material is in forms.
   d. Manufacturer shall factory prefabricate joints for crosses and tees.
   e. Split-type waterstops will not be permitted except where specifically indicated on the Drawings.

B. Joints:
   1. Construct construction and expansion joints as indicated on the Drawings.
   2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

END OF SECTION

SECTION 03_15_14

HYDROPHILIC RUBBER WATERSTOP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hydrophilic rubber waterstop.

1.02 SUBMITTALS

A. General:
   1. Submit the following items for each type, style and size of hydrophilic waterstop to be installed.
   2. Product data:
      a. Manufacturer’s product data sheets.
         1) Include complete physical dimensions, expansion characteristics, and laboratory test reports indicating that average material properties conform to the requirements specified.
         2) Provide data sheets for all materials to be included in the waterstop system.
   3. Samples:
      a. Minimum 6-inch long samples of each type of waterstop to be used if requested by the Engineer.
   4. Manufacturer's installation instructions:
      a. Installation instructions and recommended installation details for the complete waterstop system, and for each component used in that system.

PART 2 PRODUCTS

2.01 HYDROPHILIC RUBBER WATERSTOP

A. General:
   1. System composed of flexible hydrophilic urethane polymer with preformed strips, adhesives, paste, fasteners, and other accessories required for a complete and watertight installation.
      a. To ensure compatibility of materials, a single manufacturer shall provide all products and accessories for the hydrophilic waterstop system.
      b. Products incorporating bentonite are not acceptable under this Section.
      c. Provide waterstop and accessories resistant to degradation under cyclic wetting and drying.

B. Hydrophilic strip waterstop:
   1. Pre-formed strips of flexible hydrophilic rubber designed to undergo controlled expansion when exposed to moisture:
      a. Strips manufactured to limit expansion in directions parallel to the plane of the joint, and to direct expansion against confining material perpendicular to that plane.
   2. Provide normal or low-expansion pressure as scheduled and as indicated on the Drawings.
   3. Manufacturers: One of the following or equal:
      a. Hydrophilic strip:
         1) Adeka Ultra Seal USA, MC-2010MN.
         2) Sika Corp., Hydrotite CJ1020-2K.
      b. Low expansion hydrophilic strip:
         1) Adeka Ultra Seal USA, KBA-1510FP.
         2) Sika Corp., Hydrotite CJ0725-3K.

C. Hydrophilic paste waterstop.
   1. Single-component gun grade paste of hydrophilic rubber designed to undergo controlled expansion when exposed to moisture after initial curing.
   2. Manufacturers: One of the following or equal:
      a. Adeka Ultra Seal USA: P-201.
      b. Sika Corp., Leakmaster LV-Z.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and recommended details.

B. Prepare concrete joint surfaces:
   1. Use wire brushing or scraping to expose an uncontaminated, solid surface.
   2. Clean prepared surface with high-pressure air or water to remove residue and debris.
   3. Confirm that prepared surfaces conform to manufacturer’s recommendations for surface profile and moisture conditions before installing materials.

C. Provide manufacturer’s recommended lap, splice, and corner details for hydrophilic waterstops.
   1. Use hydrophilic paste at all corner joints and overlap splices of hydrophilic strips.

D. Hydrophilic strip waterstop:
   1. Install primers and adhesives when recommended by the manufacturer before setting hydrophilic strips.
   2. Keep hydrophilic strip taut during the fastening process.
   3. Secure hydrophilic strip in place with concrete nails, screws, or adhesive.

4. Provide installation with no gap between the hydrophilic strip and the concrete to which it is attached. At rough or irregular surfaces, set hydrophilic strip waterstop strip in a bead of hydrophilic paste.
    a. Fill all voids and rough areas under the hydrophilic strip with hydrophilic paste.
    b. Allow hydrophilic paste to cure in accordance with manufacturer's recommendations before encapsulating paste in fresh concrete.

3.02 SCHEDULE

A. At the following joint locations/conditions, use the hydrophilic strip waterstop configuration noted unless otherwise indicated on the Drawings.

B. Concrete construction joints:
    1. Under all of the following conditions, use hydrophilic strip waterstop set in a bed of hydrophilic paste waterstop, and screw strip waterstop to concrete surface:
        a. Slab or wall thickness is greater than 10 inches.
        b. Waterstop is placed between 2 rows of steel reinforcement.
        c. Concrete cover from waterstop to nearest concrete face is at least 4 inches.
    2. Under any one of the following conditions, use low-expansion hydrophilic strip waterstop set in bed of hydrophilic paste waterstop and screw strip to concrete surface:
        a. Waterstop is placed on 1 side of a single row of steel reinforcement.
        b. Concrete cover from waterstop to nearest concrete face is less than 4 inches.

C. Pipe penetrations through concrete:
    1. Pipe diameter less than 4 inches: Not allowed.
    2. Pipe diameter of 4 to 24 inches: Continuous bead of hydrophilic paste waterstop, minimum 1/4-inch high by 1/2-inch wide, encircling pipe.
    3. Pipe diameter greater than 24 inches: Continuous hydrophilic strip waterstop around perimeter of pipe, with hydrophilic paste seal at lapped ends of strip.

END OF SECTION

SECTION 03_20_00

CONCRETE REINFORCING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Reinforcing bars.
      a. Carbon steel.
   2. Thread bars.
   3. Bar supports.
   4. Tie wires.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.
   2. SP-66 - ACI Detailing Manual.

B. American Iron and Steel Institute (AISI).

C. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

D. ASTM International (ASTM):
   1. A493 - Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   2. A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   3. A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   4. A1064 - Standard Specification of Carbon-Steel wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

E. Concrete Reinforcing Steel Institute (CRSI):
   1. Manual of Standard Practice.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Architectural concrete: Concrete surfaces that will be exposed to view in the finished work.
      a. Additionally, for purposes of this Section, includes:
         1) Concrete surfaces that are designated to receive paints or coatings.
         2) Exposed concrete in open basins, channels, and similar liquid containing structures: Surfaces shall be considered exposed to view

if located above a line 2 feet below the normal operating water surface elevation in that structure.

2. Bars: Reinforcement or reinforcing bars as specified in this Section.
3. Evaluation Report: Report prepared by ICC-ES, or by other testing agency acceptable to the Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and its acceptance for use under the Building Code specified in Section 01_41_00 - Regulatory Requirements.
4. Give away bars: Reinforcing bars that are not required by the Contract Documents but are installed by the Contractor to provide support for the required reinforcing bars.
5. Wire supports: Metal reinforcing supports constructed of steel wire as specified. Includes individual high chairs, continuous high chairs, bolsters and other similar configurations and shapes.

1.04 SUBMITTALS

A. General:
   1. Submit in accordance with Section 01_33_00 - Submittal Procedures.
   2. Changes to reinforcement in Contract Documents:
      a. Indicate in a separate letter submitted with Shop Drawings any changes to reinforcement indicated on the Drawings or specified.
      b. Such changes will not be acceptable unless the Engineer has accepted them in writing.

B. Product data:
   1. Bar supports:
      a. Wire bar supports:
         1) Schedule of support materials to be provided and locations of use.
      b. Precast concrete bar supports (“dobies”):
         1) Manufacturer's data indicating compression strength of concrete and confirming dimensions and thickness(es), height(s) to be provided for each location where used.

C. Shop Drawings:
   1. Reinforcement Shop Drawings:
      a. Submit Drawings showing bending and placement of reinforcement required by the Contract Documents.
      b. Provide CAD generated Shop Drawings.
      c. Clearly indicate structures or portions of structures covered by each Submittal.
         1) Submit reinforcement Shop Drawings for each structure as a complete package. Submittals addressing only a portion of a structure will be rejected and returned without review, unless such presentation is accepted by the Engineer in advance.
      d. Shop Drawings shall conform to the recommendations of the CRSI Manual of Standard Practice and be in accordance with ACI SP-66.
      e. Use the same bar identification marks on bending detail Drawings, placement Drawings, and shipping tags.
      f. Submittals consisting solely of reinforcing bar schedules, without accompanying placement Drawings, will not be accepted unless accepted under prior written agreement with the Engineer.

2. Reinforcement placement Drawings:
    a. Clearly show placement of each bar listed in the bill of materials, including additional reinforcement at corners and openings, and other reinforcement required by details in the Contract Documents.
    b. Clearly identify locations of reinforcement with coatings (e.g., galvanized or epoxy) and with yield strength other than ASTM A615, Grade 60.
    c. Show anchor bolt locations based on anchor bolt templates for approved equipment.
    d. Show splice locations.
3. Reinforcement fabrication Drawings:
    a. If bend types or nomenclature differs from that recommended in the CRSI Manual of Standard Practice, provide details showing bend types and dimensional designations.
    b. Clearly identify reinforcement with coatings and with yield strength other than ASTM A615, Grade 60.

D. Samples (when requested by the Engineer):
1. Bar supports/wire reinforcement supports: Samples of each type of chair and bolster proposed for use. Submit with letter stating where each type will be used.
2. Precast concrete bar supports: Samples of each type of precast support proposed for use. Submit with letter stating where each will be used.

E. Test reports:
1. Certified copy of mill test for each steel used. Show physical properties and chemical analysis.
    a. Mill test reports may be submitted as record documents at the time the reinforcement from that heat of steel is shipped to the site.
    b. In such cases, submit certificates under the Shop Drawing Submittal number with the letter “R” (for record date) appended to the end (e.g., if the reinforcement was submitted as 03_20_00-002-1, deliver the associated mill certificate as Submittal 03_20_00-002-1R).

F. Special procedures:
1. Welding procedures in accordance with AWS D1.4 for reinforcement to be field welded.
    a. Procedures qualification record.

G. Qualifications statements:
1. Welder qualifications.

H. Closeout documents:
1. Field quality control and inspection reports.
2. Field quality assurance special inspection and testing reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance at site:
   1. Reinforcing bars: Deliver reinforcing bars lacking grade identification marks with letter containing manufacturer's guarantee of grade.

1.06 SEQUENCING AND SCHEDULING

A. Bar supports:
   1. Do not place concrete until samples and product data for bar supports have been accepted by the Engineer.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Drawings contain notes describing the size and spacing of reinforcement and its placement, details of reinforcement at wall corners and intersections, and details of extra reinforcement around openings in concrete, and other related information.

2.02 MATERIALS

A. Reinforcing bars:
   1. Provide reinforcement of the grades and quality specified, fabricated from new stock, free from excessive rust or scale, and free from unintended bends or other defects affecting its usefulness.
   2. ASTM A615 Grade 60 deformed bars, including the following requirements:
      a. Actual yield strength based on mil tests of reinforcement provided shall not exceed the minimum yield strength specified in this Section by more than 18,000 pounds per square inch.
      b. Ratio of actual ultimate tensile strength to actual tensile yield strength shall not be less than 1.25.
   3. Reinforcing bars designated or required to be welded:
      a. Low-alloy, ASTM A706 Grade 60, deformed bars.

B. Bar supports:
   1. Wire supports:
      a. All stainless steel bar supports:
         1) Conforming to CRSI Manual of Standard Practice recommendations for types and details, but custom fabricated entirely from stainless steel wire in accordance with ASTM A493, AISI Type 316.
      b. Stainless steel protected bar supports:
         1) Conforming to CRSI Manual of Standard Practice Class 2, Type B, and consisting of bright basic wire support fabricated from

cold-drawn carbon steel wire with stainless steel ends attached at the bottom of each leg.
2) Stainless steel wire ends shall be in accordance with ASTM A493, AISI Type 316 and shall extend at least 3/4 inch inward from the formed surface of the concrete.
c. Bright basic wire bar supports.
1) Conforming to CRSI Manual if Standard Practice, Class 3.
2. Plastic supports:
a. Manufacturers: The following or equal:
1) Aztec Concrete Accessories.
3. Deformed steel reinforcing bar supports:
a. Fabricated of materials and to CRSI details recommended for typical reinforcement embedded in concrete and bent to dimensions required to provide specified clearances and concrete cover.
4. Precast concrete bar supports (“dobies”):
a. Pre-manufactured, precast concrete blocks with cast-in annealed steel wires, 16-gauge or heavier.
b. Compression strength of concrete: Equal to or exceeding the compression strength of the surrounding concrete.
c. Block dimensions:
1) Height to provide specified concrete cover.
2) Footprint not less than 3 inches by 3 inches, and adequate to support the weight of the reinforcement and maintain specified concrete cover without settling into the underlying surface.

C. Tie wires:
1. General use: Black annealed steel wire, 16-gauge or heavier.

2.03 FABRICATION

A. Shop fabrication and assembly:
1. Cut and bend bars in accordance with provisions of ACI 318 and the CRSI Manual of Standard Practice.
2. Bend bars cold. Use bending collars to develop the recommended bend radius.
3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.
4. Circumferential and radiused reinforcement: Roll to the radius required for its location in the structure before installation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
1. Reinforcing bars and welded wire reinforcement:
a. Verify that reinforcement is new stock, free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings that will adversely affect bonding capacity when placed in the Work.
2. Welded wire fabric:
a. Verify that sheets are not curled or kinked before or after installation.

3.02 PREPARATION

A. Surface preparation:
   1. Reinforcing bars - uncoated:
      a. Clean reinforcement of concrete, dirt, oil and other coatings that will adversely affect bond before embedding bars in subsequent concrete placements.
      b. Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean bars having rust scale, loose mill scale, or thick rust coat.
      c. Partially embedded reinforcement: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placements.

3.03 INSTALLATION

A. Reinforcing bars: General:
   1. Field-cutting of reinforcing bars is not permitted.

Table 1. Reinforcement Placing Tolerances

Member	Tolerance on Reinforcement Location (1)	Tolerance on Minimum Concrete Cover (1,2)
Slabs, beams, walls and columns except as noted below:		
10 inches thick and less	± 3/8 inch	- 3/8 inch
More than 10 inches thick	± 1/2 inch	- 1/2 inch
Formed soffits	As noted above	- 1/4 inch
Longitudinal location of bends and ends of reinforcement:		
Conditions not listed below	± 2 inches	- 1/2 inch
At discontinuous ends of brackets and corbels	± 1/2 inch	- 1/4 inch
At discontinuous ends of other members	± 1 inch	- 1/2 inch

Notes:
(1) ± indicates “plus or minus;” - indicates “minus;” + indicates “plus.”
(2) Tolerance on cover is limited as noted but decrease in cover shall not exceed one third of the minimum cover indicated on the Drawings.

   2. Field-bending of reinforcing bars, including straightening and rebending, is not permitted.

B. Placing reinforcing bars:
   1. Accurately place bars to meet position and cover requirements indicated on the Drawings and specified. Secure bars in position.
   2. Tolerances for placement and minimum concrete cover: As listed in Table 1.

3. Spacing between bars:
    a. Minimum clear spacing between bars in a layer:
        1) As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
    b. Minimum clear spacing between bars in 2 or more parallel layers:
        1) Place bars in upper layers directly above bars in lower layers.
        2) Minimum spacing between layers: As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
    c. Limits on minimum clear spacing between bars also applies to the clear spacing between a lap splice and the adjacent bars and/or lap splices.
4. Lap splices for bars:
    a. Lap splice locations and lap splice lengths: As indicated on the Drawings. Where lap lengths are not indicated, provide in accordance with ACI 318.
    b. Unless otherwise specifically indicated on the Drawings (and noted as “non-contact lap splice”), install bars at lap splices in contact with each other and fasten together with tie wire.
    c. Where bars are to be lap spliced at concrete joints, ensure that bars project from the first concrete placement a length equal to or greater than minimum lap splice length indicated on the Drawings.
    d. Stagger lap splices where indicated on the Drawings.
    e. Where lap splice lengths are not indicated on the Drawings, provide lap splice lengths in accordance with ACI 318.

C. Reinforcing supports:
1. Provide supports of sufficient numbers, sizes, and locations to maintain concrete cover, to prevent sagging and shifting, and to support loads during construction without displacement and without gouging or indentation into forming surfaces.
    a. Quantities and locations of supports shall not be less than those indicated in ACI SP-66 and the CRSI Manual of Standard Practice.
2. Do not use brick, concrete masonry units, concrete spalls, rocks, wood, or similar materials for supporting reinforcement.
3. Do not use “give away bars” that have less cover than that required by the Contract Documents. Do not adjust the location of reinforcement required by the Contract Documents to provide cover for give away bars.
4. Provide bar supports of height required to maintain the clear concrete cover indicated on the Drawings.
5. Provide bar supports at formed vertical faces to maintain the clear concrete cover indicated on the Drawings.

6. Schedule of reinforcement support materials: Provide bar supports as indicated in Table 2.

Table 2. Reinforcement Support Materials		
Case	**Location**	**Material**
a.	Concrete placed over earth and concrete seal slabs (“mud mats”)	Precast concrete bar supports.
b.	Concrete placed against forms and exposed to water or wastewater process liquids (whether or not such concrete received additional linings or coatings)	All stainless steel bar supports.
c.	Concrete placed against forms and exposed to earth, weather, frequent washdown, or groundwater in the finished work	All stainless steel bar supports.
d.	Concrete placed against forms and exposed to interior equipment/piping areas in the finished work	All stainless steel bar supports.
e.	Between mats of reinforcement, and fully embedded within a concrete member	Bright basic wire bars supports, or deformed steel reinforcing bars.

D. Tying of reinforcing:
   1. Fasten reinforcement securely in place with wire ties.
   2. Tie reinforcement at spacings sufficient to prevent shifting.
      a. Provide at least 3 ties in each bar length. (Does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
   3. Tie slab bars at every intersection around perimeter of slab.
   4. Tie wall bars and slab bar intersections other than around perimeter at not less than every fourth intersection, but at not more than the spacing indicated in Table 3:

Table 3. Maximum Spacing of Tie Wires for Reinforcement		
Bar Size	**Slab Bar Spacing (inches)**	**Wall Bar Spacing (inches)**
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

   5. After tying:
      a. Bend ends of wires inward towards the center of the concrete section. Minimum concrete cover for tie wires shall be the same as cover requirements for reinforcement.
      b. Remove tie wire clippings from inside forms before placing concrete.

E. Welded wire fabric reinforcement:
   1. Install only where indicated on the Drawings or accepted in advance by the Engineer.

2. Install necessary tie wires, spacing chairs, and supports to keep welded wire fabric at its designated position in the concrete section while concrete is being placed.
3. Straighten welded wire fabric to make sheets flat in the Work.
4. Do not allow wire fabric to drape between supports unless such a configuration is specifically indicated on the Drawings.
    a. If fabric is displaced during placement of concrete, make provisions to restore it to the designated location using methods acceptable to the Engineer.
5. Bend welded wire fabric as indicated on the Drawings or required to fit Work.
6. Lap splice welded wire fabric as indicated on the Drawings.
    a. If lap splice length is not indicated, splice in accordance with ACI 318, but not less than 1 1/2 courses of fabric or 8 inches minimum. Tie laps at ends and at not more than 12 inches on center.

F. Welding reinforcing bars:
1. Weld only where indicated on the Drawings or where acceptance is received from the Engineer prior to welding.
2. Perform welding in accordance with AWS D1.4 and welding procedures accepted by the Engineer.
    a. Conform to requirements for minimum preheat and interpass temperatures.
3. Submit:
    a. Welding procedures specification.
    b. Procedures qualification record.
    c. Welder qualification test record.
4. Do not tack weld reinforcing bars except where specifically indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

A. Provide quality control for the Work of this Section as specified in Section 01_45_00 - Quality Control.

B. Field inspections and testing:
1. Submit records of inspections and testing to the Engineer in electronic format within 24 hours after completion.

3.05 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01_45_00 - Quality Control.

B. Special inspections and tests:
1. Provide as specified in Section 01_45_24 - Regulatory Quality Assurance.
2. Frequency of inspections:
    a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Building Code specified in Section 01_41_00 - Regulatory Requirements.
3. Preparation:
    a. Review Drawings and Specification for the Work to be observed.
    b. Review approved Submittals and Shop Drawings.

4. Inspections: Special inspection shall include, but is not limited to, the following items:
    a. Reinforcement: General:
        1) Type (material) and location of reinforcement supports.
        2) Bar material/steel grade and bar size.
        3) Location, placement, and spacing of bars.
        4) Clear concrete cover over reinforcement.
        5) Lap splice: Location and lap length. Bars within tolerances for contact (unless non-contact splice is indicated on the Drawings.)
        6) Bar hooks and development lengths embedded within concrete sections as indicated on the Drawings.
        7) Reinforcement tired in position and tie wire legs turned inward toward the center of the concrete section.
    b. Reinforcement: Welding:
        1) Inspector qualification and inspections shall be in accordance with the requirements of AWS D1.4.
        2) Provide periodic inspection for:
            a) Weldability of reinforcement other than ASTM A706.
            b) Single pass fillet welds with thickness less than or equal to 5/16 inch.
        3) Provide continuous inspection for:
            a) Other welds.
            b) Welds at mechanical reinforcing bar couplers and end anchors.
        4) In addition to visual inspection, Owner may inspect reinforcing bar welds by other methods, including radiographic inspection.
5. Records of inspections:
    a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
    b. Submit electronic copies of inspection reports to the Engineer within 24 hours after completion of inspections.

3.06 NON-CONFORMING WORK

A. Before placing concrete, adjust or remove and re-install reinforcement to conform to the requirements of the Contract Documents.

END OF SECTION

SECTION 03_21_17

ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Bonding reinforcing bars and all thread rods in concrete using adhesives.

1.02 REFERENCES

A. American Concrete Institute (ACI).
   1. 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.

B. American National Standards Institute (ANSI):
   1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.

C. ASTM international (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

D. Concrete Reinforcing Steel Institute (CRSI).

E. ICC Evaluation Service, Inc. (ICC-ES):
   1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

F. Society for Protective Coatings (SSPC):
   1. SP 1 - Solvent Cleaning.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Evaluation Service Report (ESR): Report prepared by ICC-ES or other testing agency acceptable to the Engineer and to the building official that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES acceptance criteria, and to document its acceptance for use under the building code specified in Section 01_41_00 - Regulatory Requirements.

1.04 SUBMITTALS

A. Product data: Technical data for adhesives, including:
   1. Manufacturer’s printed installation instructions (MPII).

2. Independent laboratory test results indicating allowable loads in tension and shear for concrete of the types included in this Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
3. Handling and storage instructions.

B. Quality Control Submittals:
1. Special inspection: Detailed step-by-step instructions for the special inspection procedures required by the building code specified in Section 01_41_00 - Regulatory Requirements.
2. For each adhesive to be used, Evaluation Report confirming that the product complies with the requirements of ICC-ES AC308 for both un-cracked and cracked concrete and for use in Seismic Design Categories A through F.
3. Installer qualifications:
   a. Submit evidence of successful completion of the adhesive manufacturer's installation training program.
   b. Submit evidence of current certification for installation of inclined and overhead anchors under sustained tension loading.

C. Inspection and testing reports:
1. Inspections: Field quality control: Reports of inspections and tests.
   a. Inspections: Field quality assurance: Reports of special inspections and tests.

1.05 QUALITY ASSURANCE

A. Qualifications:
1. Installation requirements:
   a. Have available at the Site and install anchors in accordance with the adhesive MPII.
2. Installer qualifications:
   a. Demonstrating successful completion of the adhesive manufacturer's on-site training program for installation of adhesive-bonded anchors.
   b. Holding current certification for installation of adhesive-bonded anchors by a qualified organization acceptable to the Engineer and to the building official.
      1) Organizations/certification programs deemed to be qualified are:
         a) ACI-CRSI Adhesive Anchor Installer Certification Program.
         b) Adhesive anchor manufacturer's certification program, subject to acceptance by the Engineer and the building official.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products as follows, unless more restrictive requirements are recommended by the manufacturer:
1. Store adhesives and adhesive components on pallets or shelving in a covered-storage area protected from weather.
2. Control temperature to maintain storage within the manufacturer's recommended temperature range.
   a. If products have been stored at temperatures outside the manufacturer's recommended range, test by methods acceptable to the Engineer to confirm acceptability before installing in the Work.
3. Dispose of products that have passed their expiration date.

1.07 PROJECT CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

B. Seismic Design Category (SDC) for structures: As specified in Section 01_81_50 - Design Criteria.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.

B. Adhesives shall have a current Evaluation Report documenting testing and compliance in accordance with ACI 355.4 and ICC-ES AC308 for use with un-cracked concrete and with cracked concrete in the seismic design category specified.

C. Bond reinforcing bars and all thread rods in concrete using epoxy adhesive unless other adhesives specified are specifically indicated on the Drawings or approved in writing by the Engineer.

2.02 EPOXY ADHESIVE

A. Materials:
   1. In accordance with the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C, depending on Site conditions.
   2. 2-component, 100 percent solids, insensitive to moisture.
   3. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

B. Packaging:
   1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through the manufacturer's static mixing nozzle.
      a. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into the prepared hole.
      b. Provide nozzle extensions as required to allow full-depth insertion and filing from the bottom of the hole.
   2. Container markings: Include the manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C. Manufacturers: One of the following or equal:
   1. Hilti, Inc., HIT-RE 500-V3.
   2. Simpson Strong-Tie Co., Inc., SET-3G.

2.03 ALL THREAD RODS

A. Materials: As specified in Section 05_12_00 - Structural Steel Framing for rods, nuts, and washers.

2.04 REINFORCING BARS

A. As specified in Section 03_20_00 - Concrete Reinforcing.

PART 3 EXECUTION

3.01 GENERAL

A. Execution of this Work is restricted to installers who have personally completed the adhesive manufacturer's on-site training for the products to be installed, and who are personally certified through a qualified certification program described under the Quality Assurance article and accepted by the Engineer and the building official.
   1. Do not install holes or adhesive until training is complete.

B. Perform Work in strict compliance with the accepted MPII and the following instructions. Where the accepted MPII and the instructions conflict, the MPII shall prevail.

C. Install reinforcing bars and all thread rods to embedment depth, and at spacing and locations indicated on the Drawings.
   1. If embedment depth is not indicated, contact the Engineer for requirements.
   2. Do not install adhesive-bonded all thread rods or reinforcing bars in upwardly inclined or overhead applications unless accepted in advance by the Engineer.

3.02 PREPARATION

A. Do not begin installation of adhesive bonded anchors until:
   1. Concrete has achieved an age of at least 21 days after placement.
   2. On-site training in installation of adhesive bonded anchors by the manufacturer's technical representative is complete. Do not drill holes in concrete or install adhesive and embeds in holes.

B. Review the MPII and "Conditions of Use" stipulated in the Evaluation Report before beginning work.
   1. Bring to the attention of the adhesive manufacturer's technical representative any discrepancies between these documents and resolve before proceeding with installation.

C. Install adhesive bonded anchors in full compliance with the MPII using personnel who have successfully completed the manufacturer's on-site training for products to be used and who hold certifications specified in this Section.

D. Confirm that adhesive and substrate receiving adhesive are within the manufacturer's recommended range for temperature and moisture conditions and will remain so during the curing time for the product.

3.03 HOLE SIZING AND INSTALLATION

A. Drilling holes:
   1. Determine location of reinforcing bars or other obstructions with a nondestructive indicator device, and mark locations with construction crayon on the surface of the concrete.
   2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without prior acceptance by the Engineer.

B. Hole-drilling equipment:
   1. Electric or pneumatic rotary impact type with medium or light impact.
      a. Installation of anchors in cored holes is not permitted.
      b. Set drill to “rotation only” mode, or to “rotation plus hammer” mode in accordance with the manufacturer’s installation instructions and the requirements of the Evaluation Report.
      c. Where edge distances are less than 2 inches and “rotation plus hammer” mode is permitted, use lighter impact equipment to prevent micro-cracking and concrete spalling during the drilling process.
   2. Drill bits: Carbide-tipped in accordance with ANSI B212-15, unless otherwise recommended by the manufacturer or required as a condition of use in the Evaluation Report.
      a. Hollow drill bits with flushing air systems are preferred. Air supplied to drill bits shall be free of oil, water, or other contaminants that will reduce bond.

C. Hole diameter: As recommended in the manufacturer’s installation instructions and the Evaluation Report.

D. Hole depth: As recommended in the manufacturer’s installation instructions to provide minimum effective embedment indicated on the Drawings.

E. Obstructions in drill path:
   1. If an existing reinforcing bar or other obstruction is hit while drilling a hole, unless otherwise accepted by the Engineer, stop drilling. Prepare and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill another hole to the required depth.
      a. Obtain the Engineer’s acceptance of distance between abandoned and relocated holes before proceeding with the relocation.
      b. Allow dry-pack mortar to cure to a strength equal to that of the surrounding concrete before resuming drilling in the area.
      c. Epoxy grout may be substituted for dry-pack mortar when accepted by the Engineer.
   2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the member and endanger the stability of the structure.
   3. When existing reinforcing steel is encountered during drilling and when specifically accepted by the Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter using pneumatic rotary impact drill.
   4. Bent bar reinforcing bars: Where edge distances are critical and interference with existing reinforcing steel is likely, if acceptable to the Engineer, drill hole

at 10-degree (or less) angle from axis of reinforcing bar or all thread rod being installed.

F. Cleaning holes:
   1. Insert air nozzle to bottom of hole and blow out loose dust.
      a. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
      b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
   2. Using a stiff bristle brush with diameter that provides contact around the full perimeter of the hole, vigorously brush hole to dislodge compacted drilling dust.
      a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
      b. Repeat at least 4 times.
   3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and in the number of cycles required by the MPII and the Evaluation Report.
   4. Leave prepared holes clean and dry.
   5. Protect prepared and cleaned holes from contamination and moisture until adhesive is installed.
   6. Re-clean and dry previously prepared holes if, in the opinion of the Engineer, the hole has become contaminated after initial cleaning.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

A. Clean and prepare inserts reinforcing bars and all thread rods:
   1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
   2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC-SP 1. Provide an oil and grease free surface for bonding of adhesive to steel.

B. Fill holes with adhesive:
   1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
   2. Fill hole as nozzle is withdrawn without creating air voids.
   3. Unless otherwise indicated on the Drawings, fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
   4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.

C. Installing reinforcing bars and all thread rods.
   1. Unless otherwise indicated on the Drawings, install bars and rods perpendicular to the concrete surface.
   2. Insert reinforcing bars and all thread rods into adhesive in accordance with the manufacturer’s recommended procedures.
   3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.

4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
5. Clean excess adhesive from the mouth of the hole.

D. Curing and loading.
1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
2. Do not disturb or load bonded embeds until the manufacturer's recommended cure time, based on temperature of the concrete, has elapsed.

3.05 POST-INSTALLATION ACTIVITIES

A. Do not bend bars or all thread rods after bonding to the concrete, unless accepted in advance by the Engineer.

B. Attachments to all thread rods:
1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.
2. Draw nuts down tight, using practices specified for "snug tight" installation of bolts in steel to steel connections.

3.06 FIELD QUALITY CONTROL

A. Provide field quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control.

B. Do not allow Work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.

C. Manufacturer's services:
1. Before beginning installation, adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
a. Provide notice of scheduled training to the Engineer and to special inspector(s) not less than 10 working days before training occurs. Engineer and special inspector may attend training sessions.
2. Submit record, signed by the manufacturer's technical representative, listing the Contractor's personnel who completed the training. Only qualified personnel who have completed the manufacturer's on-site training shall perform installations.

D. Field inspections and testing:
1. Hole drilling and preparation.
2. Results: Submit records of inspections and testing to the Engineer by electronic copies within 24 hours after completion.

3.07 FIELD QUALITY ASSURANCE

A. Provide field quality assurance over the Work of this Section as specified in Section 01_45_00 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01_45_24 - Regulatory Quality Assurance.
   2. Frequency of inspections:
      a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
      b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rod. Subsequent installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.
      c. Provide continuous inspection of drilling, cleaning and bonding activities for bars and rods installed in horizontal and upwardly inclined positions.
   3. Preparation:
      a. Review Drawings and Specifications for the Work to be observed.
      b. Review the adhesive manufacturer's MPII and recommended installation procedures.
      c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.
   4. Inspection: Periodic:
      a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread rod material being installed. During initial inspection, observe the following for compliance with the installation requirements.
         1) Concrete: Class (minimum specified compressive strength) and thickness.
         2) Environment: Temperature conditions at the work area and moisture conditions of concrete and drilled hole.
         3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures; cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MPII, and the "Conditions of Use" listed in the Evaluation Report.
         4) Adhesive: Product manufacturer and name, lot number and expiration date, temperature of product at installation, installation procedure. Note initial set times observed during installation.
         5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.

b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:
    1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.
    2) For ongoing installations, the special inspector visits the Site at least once for every 4 hours of work during each day of installation to observe the Work for compliance with material requirements and installation procedures.

5. Inspection: Continuous.
    a. Make observations as described under “Inspection - Periodic, Initial Inspection” during drilling, cleaning, and bonding activities for all bars and rods installed.
6. Records of inspections:
    a. Provide a written record of each inspection using forms acceptable to the Engineer and to the building official.
    b. Submit electronic copies of inspection reports to the Engineer within 24 hours after completion of inspection.

END OF SECTION

SECTION 03_30_00

CAST-IN-PLACE CONCRETE

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PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cast-in-place concrete.

B. The requirements of this Section require advance planning for preparation and testing of trial batches. Review the mix design and testing requirements carefully, and schedule preparations and testing with sufficient time to complete tests, to obtain the Engineer's review of mixes and testing results, and to complete revisions and re-testing if required.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. CODE-318 - Building Code Requirements for Structural Concrete and Commentary.
   2. CODE-350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   3. PRC-212.3 - Report on Chemical Admixtures for Concrete.
   4. PRC-302.1 - Guide to Concrete Floor and Slab Construction.
   5. PRC-305 - Guide to Hot Weather Concreting.
   6. PRC-306 - Guide to Cold Weather Concreting.

B. ASTM International (ASTM):
   1. C29 - Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
   2. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   3. C33 - Standard Specification for Concrete Aggregates.
   4. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   5. C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   6. C42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   7. C88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   8. C94 - Standard Specification for Ready-Mixed Concrete.
   9. C114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement.
   10. C117 - Standard Test Method for Materials Finer that 75-m (No. 200) Sieve in Mineral Aggregates by Washing.
   11. C123 - Standard Test Method for Lightweight Particles in Aggregate.
   12. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   13. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   14. C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
   15. C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregate.

16. C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
17. C150 - Standard Specification for Portland Cement.
18. C156 - Standard Test Method for Water Loss from a Mortar Specimen Through Liquid Membrane-Forming Curing Compounds for Concrete.
19. C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
20. C171 - Standard Specifications for Sheet Materials for Curing Concrete.
21. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
22. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
23. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
24. C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading).
25. C295 - Standard Guide to Petrographic Examination of Aggregates for Concrete.
26. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
27. C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
28. C494 - Standard Specification for Chemical Admixtures for Concrete.
29. C595 - Standard Specification for Blended Hydraulic Cements.
30. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
31. C702 - Standard Practice for Reducing Samples of Aggregate to Testing Size.
32. C856 - Standard Practice for Petrographic Examination of Hardened Concrete.
33. C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars.
34. C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
35. C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
36. C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
37. C1260 - Standard Test Method of Potential Alkali Reactivity of Aggregates (Mortar Bar Method).
38. C1293 - Standard Test Method for Determination of Length Change of Concrete due to Alkali-Silica Reaction.
39. C1567 - Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
40. C1602 - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
41. C1778 - Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete.
42. D75 - Standard Practice for Sampling Aggregates.
43. D2103 - Standard Specification for Polyethylene Film and Sheeting.
44. D3665 - Standard Practice for Random Sampling of Construction Materials.
45. D4791 - Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

C. National Ready-Mixed Concrete Association (NRMCA).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Alkali: The sum of sodium oxide and potassium oxide calculated as sodium oxide.
   2. Alkali load: Amount of alkalies contributed by the Portland cement in a concrete mixture, expressed in pounds per cubic yard (lb/yd^3) and calculated by multiplying the Portland cement content of the concrete in lb/yd^3 by the alkali content of the Portland cement, or the Portland cement portion of a blended cement, divided by 100.
   3. Architectural concrete: Concrete surfaces that will be exposed to view in the finished Work.
      a. For purposes of this Section, includes only those surfaces that receive paint or coatings.
      b. Exposed concrete surfaces in open basins, channels, and similar liquid containing structures: Surfaces will be considered exposed to view if located above the water line as defined in Section 03_35_29 - Concrete Finishes.
      c. Exterior concrete surfaces with portions above and below grade: Surface will be considered exposed to view of located above the grade line as defined in Section 03_35_29 - Concrete Finishes.
   4. Average daily temperature: Calculated by summing hourly measurements of air temperature in the shade at the face of the concrete and dividing that sum by 24. In calculating the sum of the temperatures recorded, any measurement less than 50 degrees Fahrenheit shall be recorded as 0 degrees Fahrenheit and included in the sum.
   5. Cementitious materials: Portland cement or blended cement and supplementary cementitious materials.
   6. Class of concrete: Refers to a mix with characteristics, proportions, and constituents (including a specific combination of admixtures) as specified in this Section.
      a. Any change in the source or characteristics of constituent materials, in the proportions of materials, or in the admixtures included in a mix shall be considered as creating a new and separate class of concrete.
      b. Any mix to be placed by pumping shall be considered as creating a new and separate class of concrete.
   7. Cold weather: Includes one or more of the following conditions:
      a. Current air temperature is 45 degrees Fahrenheit and falling.
      b. Air temperature during the first 24 hours after placement is expected to fall into the range of 45 degrees Fahrenheit to 40 degrees Fahrenheit.
      c. A period when, for more than 3 consecutive days, the following conditions exist:
         1) The average daily air temperature drops below 40 degrees Fahrenheit.
         2) The air temperature is not greater than 50 degrees Fahrenheit for more than one-half of any consecutive 24-hour period.
   8. Cold weather concreting: Operations for placing, finishing, curing, and protecting concrete during cold weather.
   9. Green concrete: Concrete that has not yet achieved 100 percent of the minimum specified compressive strength, f'c, for that mix.

10. Hairline crack: Crack with a crack width of less than 4 thousandths of an inch (0.004 inches).
11. Hot weather: Any combination of ambient temperature, concrete temperature, relative humidity, wind speed, and solar radiation intensity that creates conditions that will evaporate water from a free concrete surface at a rate equal to or greater than 0.2 pounds per square foot per hour as determined by the Menzel Formula and nomograph published in ACI PRC-305 and in this Section, Attachment A - Menzel Formula and Nomograph.
12. Hot weather concreting: Operations for placing, finishing, curing, and protecting concrete during hot weather.
13. Paste content: The total concrete volume minus the volume of aggregate, expressed as a percentage of total volume. Paste volume includes volume of cementitious materials, water, air, admixtures materials, and any fibers.
14. Supplemental cementitious material: Inorganic material such as fly ash, natural pozzolans, silica fume, or slag cement that reacts pozzolanically or hydraulically.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Concrete mix designs.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. General:
   1. Data for concrete mixes and mix constituents supplied to the Work shall be coordinated through a single supplier.
   2. A maximum of 2 mix designs will be reviewed by the Engineer for each class of concrete required.
      a. Review of additional mix designs shall be at the expense of the Contractor.

C. Product data:
   1. Submit data completely describing products and demonstrating compliance with the requirements of this Section.
   2. Data for all products in the mix for each class of concrete shall be submitted concurrently with that mix design.
   3. Where products conforming to NSF 61 are required, submit evidence of testing and listing under NSF 61 for use in direct contact with potable water. Testing and listing shall be by a nationally recognized agency acceptable to the Engineer.
   4. Admixtures:
      a. For each admixture included in concrete mixes, submit manufacturer’s product data demonstrating compliance with standards specified.
      b. If air entraining admixture requires test method other than ASTM C173 to accurately determine air content, make special note of requirements in Submittal.
   5. Curing compound: Submit complete data on proposed compound.

D. Delegated Design Submittals:
    1. Concrete mix designs:
        a. Submit full details, including mix design calculations and plots, for concrete mixes proposed for use for each class of concrete.
        b. Include mix design calculations of proportions by both weight and volume.
        c. Determine and include the alkali load of the proposed mix.
        d. Include information on correction of batching for varying moisture contents of fine aggregate.
        e. Submit source quality test records with mix design Submittal.
        f. Provide calculations demonstrating that the mixes proposed provide the required average compression strength of concrete (f'cr) based on source quality test records.
        g. For each Class A mix design submitted, plot the mix design Attachment B - Coarseness Factor Chart and submit.
        h. For each Class A mix design submitted, plot the combined aggregate gradation on the chart Attachment C - Combined Aggregate Gradation Chart and submit.

E. Concrete mixes - Trial batches:
    1. Drying shrinkage test results.
        a. Submit results of testing.
        b. Submit test specimens from drying shrinkage tests for trial batches.
            1) Submit specimens from each mix accepted by the Engineer.
            2) Using indelible marker, clearly label each specimen with concrete class, trial batch mix designator, and specimen number.
    2. Compression strength test results.
        a. Submit results of testing. Provide data for each cylinder tested.
        b. Submit data indicating trial batch mix designator, slump, and specimen number for each test cylinder.
        c. Submit test specimens from compression strength tests for trial batches.
            1) Submit 2 cylinders from each mix accepted by the Engineer.
            2) Using indelible marker, clearly label each cylinder with concrete class, trail batch number, and specimen number.
    3. If there is any change in suppliers or in quality of concrete mix constituents, submit new test data.

F. Test reports:
    1. Dated not more than 24 months prior to the date of Submittal.
    2. Aggregate:
        a. Submit certified copies of commercial laboratory tests proposed for use in concrete.
        b. Sieve analyses:
            1) During construction, submit sieve analyses of coarse, intermediate, fine, and combined aggregates used any time there is a change in supplier, or a significant change in the character and/or grading of materials, and when requested by the Engineer.
        c. Aggregates - coarse:
            1) Physical properties:
                a) Sieve analysis.
                b) Percentage of particles having flat and/or elongated characteristics.

c) Abrasion loss.
d) Soundness.

2) Deleterious substances:
a) Clay lumps and friable particles content.
b) Materials finer than No. 200 sieve (percentage).
c) Shale and chert content.
d) Coal and lignite content.

3) Alkali reactivity.
4) Petrographic analysis.

d. Aggregates - Intermediate:
1) Physical properties:
a) Sieve analysis.
b) Percentage of particles having flat and/or elongated characteristics.
c) Abrasion loss.
d) Soundness.

2) Deleterious substances:
a) Clay lumps and friable particles content.
b) Chert and shale content.
c) Coal and lignite content.
d) Materials finer than No. 200 sieve.

3) Alkali reactivity.
4) Petrographic analysis.

e. Aggregates - Fine:
1) Physical properties:
a) Sieve analysis and fineness modulus.
b) Soundness.

2) Deleterious substances:
a) Clay lumps and friable particles (percentage).
b) Materials finer than No. 200 sieve (percentage).
c) Coal and lignite (percentage).
d) Shale and chert.
e) Organic impurities (“Color” as determined by ASTM C40).

3) Alkali reactivity.
4) Petrographic analysis.

f. Aggregates - Combined:
1) Test combined gradation for the following sieve sizes: 1.5 inches, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 100, No. 200.
2) Bulk density in accordance with ASTM C29.
3) Void content in accordance with ASTM C29.
4) Submit at:
a) Initial mixture design Submittal.
b) Intervals of not more than 4 weeks.
c) Any time there is a change in character or grading of constituent materials.
d) When requested by the Engineer.

3. Cement:
    a. Mill tests, including alkali content measured as equivalent alkalies, for each shipment of cement included in the Work.
        1) During construction, submit mill certificates for cement being used at intervals of not more than 90 days, any time there is a change in supplier or a significant change in the character of the materials, and when requested by the Engineer.
4. Supplemental cementitious material:
    a. Fly ash: Identify source and provide testing results to demonstrate compliance with requirements of ASTM C618 and this Section.
        1) Include the Supplier's report certifying the total alkali content of the material, expressed as equivalent percentage of sodium oxide (Na_2Oe).
    b. Slag cement: Identify source and provide testing results to demonstrate compliance with requirements of ASTM C989 and this Section.
    c. Silica fume: Identify source and provide testing results to demonstrate compliance with requirements of ASTM C1240 and this Section.

G. Certificates:
1. Current NRMCA certification for all plants and trucks that will be used to supply concrete.

H. Source Quality Control Submittals:
1. Truck batch tickets for each load of concrete delivered to the Site, whether accepted or rejected.
2. Concrete supplier's quality control plan. Include the following elements, at a minimum:
    a. Names and qualifications of key quality control personnel:
        1) Quality control manager.
        2) Testing and inspection personnel.
    b. Names and qualifications of testing laboratories:
        1) Each laboratory shall hold current accreditation from the AASHTO Accreditation Program, or other accreditation program acceptable to the Engineer, for each test performed.
    c. Example forms for: Inspection reports, certificates of compliance, and test results.
    d. Quality control procedures: Method and frequency of performing each procedure, including inspections and materials testing. At a minimum, the plan shall include:
        1) Daily testing of aggregate gradation.
        2) Monthly testing of cement quality.
        3) Monthly testing of fly ash quality.
    e. Procedures to control quality characteristics, including standard procedures to address properties outside the specified operating limits, and example reports to document non-conformances and corrective actions taken. Include procedure for notifying the Contractor and Engineer of non-conformances.
    f. Procedures for verifying that:
        1) Materials are properly stored during concrete batching operations.
        2) Batch plants have the ability to maintain concrete consistency during periods of extreme heat and of low temperatures.

3) Admixtures are dispensed in the correct dosages within the accuracy requirements specified.
4) Delivery trucks have a valid NRMCA certification card.

g. Procedures for verifying that weighmaster certificate for each load of concrete shows:
1) Cement and supplementary materials are from sources designated in the approved Submittals.
2) Concrete as-batched complies with the constituent weights designated in the approved Submittals.
3) Corrections for aggregate moisture are being correctly applied.
4) Any mix water withheld from the batch.

h. Procedures for visually inspecting concrete during discharge.

I. Field Quality Control Submittals:
1. Contractor's notifications of readiness for concrete placement.
2. Contractor's reports of field quality control testing.
a. Include with each report the concrete batch ticket number and identification numbers for associated cylinders used for compressive strength testing.
b. Testing results for slump, temperature, unit weight, and air entrainment.
c. Testing results for compressive strength at 7 and 28 days, and for any compressive strength tests after 28 days.
d. Note on batch ticket the amount of water that was withheld and the maximum amount that can be added on site as "Max add water." Record on the batch ticket the volume of water actually added at the Site.
e. Note on the batch ticket the concrete mix classification as defined in Table 3 of this Section.

J. Special procedure Submittals:
1. Sequence of concrete placing:
a. Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements. Submittal shall include plans sections and details to address all pours.
2. Cold weather concreting plan.
3. Hot weather concreting plan.
4. Repair of defective concrete: Submit mix design for repair materials to be used.

1.06 QUALITY ASSURANCE

A. Pre-installation meetings:
1. Schedule and conduct pre-installation meeting at least 10 days prior to batching and placing of concrete.
a. Provide additional meetings if necessary, to discuss specific concrete Submittals, mixes, or placing and curing conditions.
b. Notify the Engineer of location and time of each conference.
2. Required attendees:
a. Contractor, including Contractor's superintendent and key personnel.
b. Concrete supplier.
c. Technical representative(s) of supplier(s) of concrete admixtures.
d. Subcontractor(s) providing pumping, placing, finishing, and curing.
e. Subcontractor(s) providing embedded items (structural embedded plates, electrical conduit).

f. Sampling and testing personnel.
g. Engineer.
h. On-site inspectors representing the Engineer.
i. Other persons deemed by the Engineer and the Contractor to be critical to the quality and efficiency of the Work.

3. Agenda:
   a. Review of requirements of Drawings and Specifications.
   b. Project and product safety requirements.
   c. Discussion of points of interface and coordination between various trades or products to be used in the Work.
   d. Contractor's schedule for cast-in-place concrete work.
   e. Mix designs, mix tests, and Submittals.
   f. Admixture types, dosing, performance, requirements for monitoring, and limits on dosing or re-dosing at the Site.
   g. Placement and consolidation methods, techniques, and equipment and the effects of those methods on form pressures.
   h. Slump and limits on placing time or conditions to maintain placeability.
      1) Field adjustment of slump and air content.
   i. Procedures for finishing, curing, and retention of moisture during these operations.
   j. Procedures and protection for hot and cold weather conditions.
   k. Requirements and coordination for inspections.
      1) Responsibility for test specimen curing and storage.
      2) Distribution of test reports.
   l. Other Specification requirements requiring coordination between parties to the Work.
4. Prepare and submit minutes of the pre-installation meeting as specified in Section 01_31_19 - Project Meetings.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver, store, and handle concrete materials in a manner that prevents damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.
   4. For Class M concrete:
      a. Store coarse and fine aggregate in covered area. Shade aggregates to prevent heating by direct sunlight.
      b. Store cementitious materials in covered, shaded silos to prevent heating by direct sunlight.

B. Acceptance at Site:
   1. Reject material containers or materials showing evidence of water or other damage.
   2. Concrete mixes: Do not accept or incorporate into the Work concrete mixes that do not comply with the specified requirements for water content, slump, temperature, and air content.

1.08 PROJECT CONDITIONS

A. Cold weather concreting: During periods of cold weather as defined in this Section, implement cold weather concreting procedures in this Section.

B. Hot weather concreting: During periods of hot weather as defined in this Section, implement hot weather concreting procedures in this Section.

1.09 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in a manner that completes all placing operations from one construction, contraction, or expansion joint to another construction, contraction, or expansion joint.

B. Joints at each end of the placement shall be as indicated on the Drawings, or as identified and accepted in advance by the Engineer.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide concrete with a homogeneous mixture, that, when hardened, will have required strength, watertightness, and durability.

B. Provide a workable, low-shrinkage concrete mix that maximizes aggregate content and minimizes paste content.

C. Performance requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of Portland cement or blended cement, supplemental cementitious materials, aggregate, admixtures and water, proportioned and mixed to produce a plastic, workable mixture in accordance with requirements of this Section, and suitable to specific conditions of placement.
      b. Proportion aggregates to produce an optimized gradation of aggregate that combines fine, intermediate, and coarse aggregate in well-graded proportions that maximizes the aggregate content and minimizes the paste content of the mix. Gradation should maximize long-term durability and strength of the concrete mixture.
      c. Durability requirements will be deemed to be satisfied when:
         1) Mixture is proportioned with a well-graded combined aggregate.
         2) Specified water-cement ratio is satisfied.
         3) Concrete contains the specified range of air content.
         4) Maximum specified paste content is satisfied.

5) Requirements of ASTM C1778 to reduce the risk of deleterious alkali-aggregate reactions are satisfied. Reduce alkali loading of concrete, provide minimum supplemental cementitious material content, or both as required.
a) Size and exposure conditions (ASTM C1778, Table 2): Concrete exposed to humid air, buried or immersed.
b) Structure class (ASTM C1778, Table 3): Class SC4.

d. Proportion materials in a manner that will secure the lowest cement content, water-cementitious materials ratio, and paste volume that is consistent with good workability that provides a plastic and cohesive mixture, and that provides a slump that is within the specified range.
e. Construction and expansion joints have been positioned in structures as indicated on the Drawings, and curing methods have been specified, for purpose of to reduce the number and size of cracks, resulting from normal expansion and contraction expected from the concrete mixes specified.
f. Remove and replace, or repair as specified in this Section, non-conforming work and surfaces with cracks, voids and honeycombs, or surface wetness.

2. Workmanship and methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI CODE-318, and ACI CODE-350.

2.02 MATERIALS - GENERAL

A. Water and ice:
1. Water for concrete mixes, for washing aggregate, and for curing concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
2. Do not use water from concrete production operations, or combined water from concrete production operations as defined in ASTM C1602.

2.03 MATERIALS - CONCRETE MIX CONSTITUENTS

A. Water and ice:
1. As specified in the preceding paragraphs.

B. Cementitious materials:
1. Portland cement:
a. In accordance with ASTM C150.
1) Type II, or Type II (MH) as scheduled for each mix.
b. Single source: To provide uniformity of appearance, for each structure use only one source, type, and brand of Portland cement for walls and slabs that will be exposed in the finished Work.
1) Confirm adequate supply of cement over duration of the Project before making trial batches or beginning concrete placements.
c. Cement for finishing: Provide cement from the same source and of the same type as concrete to be finished or repaired.
2. Blended hydraulic cement:
a. In accordance with ASTM C595:
1) Type IL (MS).
b. Single source: To provide uniformity of appearance and quality, for each structure use only one source, type, and brand of cement.

c. Confirm adequate supply of cement over duration of the Project before making trial batches or beginning concrete placements.
d. Cement for finishing: Provide cement from same source and of same type as concrete to be finished or repaired.

C. Supplementary cementitious materials:
1. Fly ash:
a. Class C or Class F fly ash in accordance with the requirements of ASTM C618, except as modified in this Section.
1) Class C may be used in concrete made with Type II Portland cement.
2) Class F required if used in concrete mixes containing aggregates classified as potentially reactive based on ASTM C1293 or ASTM C1260.
a) CaO content: Less than 18 percent.
b. Loss on ignition: Not exceeding 3 percent.
c. Replace Portland cement at ratio of 1.0 pound fly ash for each pound of cement, up to minimum and maximum replacement as specified in Requirements for mix proportioning.
2. Slag cement:
a. Grade 80, 100, or 120 in accordance with ASTM C989, except as modified below:
1) Fineness: Amount retained on a No. 325 sieve: 20 percent maximum.
2) Total alkalies Na2O + 0.658 K2O:
a) Minimum: 0.60 percent.
b) Maximum: 0.90 percent.
3. Silica fume:
a. In accordance with ASTM C1240, except as modified below:
1) Moisture content: 3 percent maximum.
2) Loss on ignition: 6 percent maximum.
3) Reactivity with cement alkalies: 80 percent minimum.
4) Sulfate resistance: Maximum 0.05 percent expansion at 1 year.

D. Admixtures:
1. General:
a. Do not include admixtures, other than those specified, unless written acceptance has been obtained from the Engineer during Submittal of mix designs.
b. Compatible with concrete constituents and with other admixtures.
1) All admixtures in a given mix shall be products of the same manufacturer to ensure compatibility.
2) Manufacturers: One of the following or equal.
a) Euclid Chemical.
b) GCP Applied Technologies (formerly W.R. Grace).
c) Master Builders Solutions/Sika.
d) Sika Corp.
c. Do not use admixtures containing chlorides, calculated as chloride ion, in excess of 0.5 percent by weight of cement.
d. Use in accordance with manufacturer’s recommendations. Add each admixture to concrete mix separately.
e. Admixtures used shall be the same products used in concrete trial batches, or the same products used in concrete represented by submitted field test records.

2. Air entraining admixture (AEA):
    a. In accordance with ASTM C260 and dosed to provide entrained air percentages specified in this Section.
    b. Provides entrained air as bubbles, evenly dispersed at the time of placement and during curing.
3. Water reducing admixture (WRA):
    a. May be used at the Contractor's option.
    b. In accordance with ASTM C494, Type A (water-reducing).
        1) ASTM C494, Type D (water-reducing and retarding) may be used during periods of hot weather with prior acceptance by the Engineer.
    c. Not containing air-entraining agents.
    d. Liquid form before adding to the concrete mix.
4. High-range water reducing admixtures (superplasticizers) (HRWR):
    a. Not permitted without acceptance by the Engineer.
5. Shrinkage reducing admixture (SRA):
    a. May be used at the Contractor's option.
        1) Provide shrinkage reducing admixture in sufficient dosage so as to produce shrinkage within the limits specified.
    b. Not containing expansive agents.
    c. In accordance with ASTM C494, Type S (specific performance).
    d. One of the following or equal:
        1) Euclid Chemical: Eucon SRA Series.
        2) GCP Applied Technologies: Eclipse Series.
        3) Master Builders Solutions/Sika: SRA Series.
6. Set-controlling admixtures:
    a. Shall not be used without prior acceptance from the Engineer.

E. Coloring admixtures:
1. Conduit encasement coloring agent:
    a. Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
    b. Manufacturers: One of the following or equal:
        1) Davis Co., #100 Utility Red.
        2) Euclid Chemical Co., Increte Division, Colorcrete Brick Red.
        3) I. Reiss Co., Inc., equivalent product.
    c. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

F. Aggregate:
1. General:
    a. Provide concrete aggregates that are sound, graded as specified, and free of deleterious material in excess of allowable amounts specified.
    b. Provide aggregates to produce in place concrete with unit weight as follows:
        1) Normal weight concrete: Not less than 140 pounds per cubic foot.
    c. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.
    d. Do not use aggregate recycled from fresh concrete returned to the batching facility.

2. Alkali-silica reactivity:
    a. Provide aggregate classified as aggregate-reactivity class of R0 in accordance with ASTM C1778 with expansion not greater than 0.10 percent at 14 days when tested in accordance with ASTM C1260, and not greater than 0.04 percent at 1 year when tested in accordance with ASTM C1293.
    b. Aggregates classified as potentially reactive based on the preceding tests may be permitted, at the discretion of the Engineer, if the following condition is satisfied:
        1) ASTM C1567: Testing with the reactive aggregate, cement, and supplemental cementitious materials demonstrate that expansion is less than 0.10 percent at 14 days. Include ASTM C1260 and ASTM C1293 test results to demonstrate that mitigation of alkali-silica reaction by ASTM C1567 is suitable. See Figure 3 of ASTM C1778 for reactivity of aggregates where ASTM C1567 testing is not recommended.
3. Fine aggregate:
    a. Material graded such that 95 to 100 percent of material passes the No. 4 (4.75 mm) sieve, when sampled in accordance with ASTM D75 and ASTM D3665, and tested in accordance with ASTM C136.
    b. Provide fine aggregate consisting of clean, natural sand, or sand prepared from crushed stone or crushed gravel.
    c. In accordance with ASTM C33 requirements for grading, deleterious substances, soundness, and alkali reactivity, except as modified in the following paragraphs:
        1) Grading: For sieve sizes listed in ASTM C33 for fine aggregate, not more than 45 percent passing any sieve and retained on the next consecutive sieve.
        2) Deleterious substances: Not in excess of the percentages by weight specified in Table 1 of this Section.

Table 1. Fine Aggregate, Limits on Deleterious Substances

Item	Test Method	Percent (maximum)
Materials finer than No. 200 sieve(2)	ASTM C117	3.00(2)
Clay lumps and friable particles	ASTM C142	1.00
Lightweight particles (SG < 2.40)	ASTM C123	1.00
Chert or shale(1)	ASTM C295	1.00(1)
Coal and lignite	ASTM C123	0.50

Notes:

(1) ASTM C123 tests for particles in the sample having a specific gravity less than 2.40. ASTM C295 is used to identify which of those lightweight particles are chert, shale, or coal and lignite. If testing under ASTM C123 indicates a combined percentage of lightweight particles (sum of shale, chert, coal and lignite) not greater than 1.00, testing under ASTM C295 will not be required.

(2) For manufactured sand, if material finer than the No. 200 sieve consists of crusher dust and the aggregate is essentially free of clay or shale, maximum percentage may be increased to 5.0 percent.

3) Organic impurities: Free of injurious amounts of organic matter and producing a supernatant liquid with color not darker than “standard color” when tested in accordance with ASTM C40.
4) Soundness: In accordance with requirements of ASTM C33 when tested in accordance with ASTM C88 using sodium sulfite solution.

4. Intermediate aggregate:
   a. Material graded such that 90 to 100 percent of material passes the 3/8-inch sieve, and not more than 5 percent of material passes the No. 50 (300 µm) sieve, when sampled in accordance with ASTM D75 and ASTM D3665 and tested in accordance with ASTM C136.
   b. Requirements for maximum percentage of impurities, abrasion loss, and soundness: As specified for coarse aggregate.
5. Coarse aggregate:
   a. Materials graded such that not more than 10 percent of material passes the 3/8-inch sieve, when sampled in accordance with ASTM D75 and ASTM D3665 and tested in accordance with ASTM C136.
   b. Consisting of gravel, crushed gravel, crushed stone, or a combination of these materials having clean, hard, durable particles free from calcareous coatings, organic matter, or other deleterious substances.
   c. Conforming to the requirements of ASTM C33, Class 4S for physical properties, deleterious substances, and alkali reactivity, except as modified in the following paragraphs:
      1) Grading:
         a) Size number as specified in ASTM C33, and as indicated in Table 3 of this Section, except as otherwise specified or accepted by the Engineer.
         b) Weights of flat or elongated particles (particles having a length greater than 3 times average width or thickness) not exceeding 15 percent when tested in accordance with ASTM D4791.
      2) Deleterious substances: Not in excess of the percentages by weight specified in Table 2 of this Section and having total of all deleterious substances exceeding 2 percent.

Table 2. Coarse Aggregate, Limits on Impurities

Item	Test Method	Percent (maximum)
Clay lumps and friable particles	ASTM C142	0.50
Lightweight particles (SG < 2.40)	ASTM C123	1.25
Chert or shale(1)	ASTM C295	1.00(1)
Materials finer than No. 200 sieve	ASTM C117	0.50(2)
Coal and lignite	ASTM C123	0.25

Notes:

(1) ASTM C123 tests for particles in the sample having a specific gravity less than 2.40. ASTM C295 is used to identify which of those lightweight particles are chert, shale, or coal and lignite. If testing under ASTM C123 indicates a combined percentage (sum of shale, chert, coal and lignite) not greater than 1.25, testing under ASTM C295 will not be required.

(2) When material finer than No. 200 sieve consists of crusher dust, maximum percentage may be increased to 1.00 percent. When mix design complies with provisions of ASTM C33, Table 4, footnote C, the maximum percentage may be increased in accordance with the equation in footnote C, up to a maximum of 1.5 percent.

3) Abrasion loss: Loss not greater than 45 percent after 500 revolutions when tested in accordance with ASTM C131.
4) Soundness: Loss not greater than 10 percent when tested in accordance with ASTM C88 using sodium sulfate solution.

2.04 MATERIALS FOR PLACING, CURING AND FINISHING

A. General:
1. Materials shall be compatible with concrete and with other materials.

B. Cement grout:
1. Use: For spreading over surface of construction and cold joints in concrete before placing additional concrete above those joints.
2. As specified in Section 03_60_00 - Grouting.

C. Concrete sealer:
1. As specified in Section 03_35_29 - Concrete Finishes.
2. Not for use in water-containment structures.

D. Evaporation retardant:
1. Use: For mitigating surface moisture evaporation from freshly placed concrete during rapid drying conditions. Placed after screeding.
2. Waterborne, monomolecular, spray-applied compound, with fugitive dye to indicate coverage.
3. Manufacturers: One of the following or equal:
   a. Euclid Chemical Co., Eucobar.
   b. Master Builders Solutions/Sika, MasterKure ER 50.

E. Nonslip abrasive:
1. Aluminum oxide abrasive size 8/16, having structure of hard aggregate that is, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
2. Manufacturers: One of the following or equal:
   a. Abrasive Materials, Inc.
   b. Exolon Co.

F. Plastic membrane for curing:
1. Polyethylene film: In accordance with ASTM C171.
2. Properties:
   a. Color: White.
   b. Thickness: Nominal thickness of polyethylene film shall not be less than 0.0040 inches when measured in accordance with ASTM D2103. Thickness of polyethylene film at any point shall not be less than 0.0030 inches.
   c. Loss of moisture: Not exceeding 0.055 grams per square centimeter of surface when tested in accordance with ASTM C156.

G. Sprayed membrane curing compound:
1. Combination curing and sealing products (cure and seal) will not be permitted.

2. Properties:
    a. Clear type with fugitive dye conforming with ASTM C309, Type 1D and containing no wax, paraffin, or oils.
    b. For concrete placed or cured during hot weather, curing compound shall be as specified, except that:
        1) It shall include a white, reflective fugitive dye.
        2) Moisture loss during a 72-hour period shall not exceed 0.55 kg/square meter when tested in accordance with ASTM C156.

H. Surface-applied crystalline coating:
1. Manufacturers: One of the following or equal:
    a. Euclid Chemical Co., Vandex Super.
    b. Kryton International, Inc., Krystol T1.
    c. Xypex Chemical Corp., Xypex Concentrate.
2. Where surface-applied crystalline coating is placed over concrete containing permeability reducing admixture for concrete exposed to hydrostatic conditions (PRAH), provide products of same manufacturer providing the admixture.

2.05 EQUIPMENT

A. General:
1. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material into mixers.

B. Batching equipment, or batch plant.
1. Capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.

C. Mixing equipment:
1. Mixers may be of stationary plant, paver, or truck mixer type, as appropriate to the Work.
2. Capable of combining aggregates, water, and cementitious materials, and admixtures within specified time into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation.
    a. Maintain concrete mixing equipment in good working order, and operate at loads, speeds, and timing recommended by manufacturer or as specified.
    b. Proportion cementitious materials and aggregate by weight.
3. If bulk cementitious materials are used, weigh them on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
4. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
5. Procedure of mixing cementitious materials with sand or with sand and coarse aggregate for delivery to the Project Site, for final mixing and addition of mixing water will not be permitted.
6. Retempering of concrete will not be permitted.
7. Discharge entire batch before recharging.
8. Volume of mixed material per batch: Not to exceed manufacturer’s rated capacity of mixer.

9. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
10. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing:
    a. Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.
11. Transit-mixed concrete:
    a. Mix and deliver in accordance with ASTM C94.
    b. Total elapsed time between addition of water at batch plant and discharging completed mix.
    c. Not to exceed 90 minutes.
    d. Elapsed time at the Project Site shall not exceed 30 minutes.
    e. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the Engineer.
    f. Equip each truck mixer with device interlocked to prevent discharge of concrete from drum before required number of turns and furnish device that is capable of counting number of revolutions of drum.
12. Continuously revolve drum after it is once started until it has completely discharged its batch:
    a. Do not add water until drum has started revolving.
    b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. Contractor will not be entitled to additional compensation because of such increase or decrease.

D. Other types of mixers: For other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than 1 cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.06 CONCRETE MIXES

A. General:
1. Develop and provide mix designs for each concrete class listed in Table 3 of this Section.
2. Select and proportion mixes and document properties using one of the 2 methods that follow. Procedures and requirements for use of each alternative are specified in subsequent paragraphs of this Section.
    a. Field experience method.
    b. Trial batch method.
3. Organize and submit mix designs with data on all constituent materials and products for that mix for the Engineer's review.
4. Do not place concrete until the mix design for that concrete class has been accepted by the Engineer.

5. After acceptance, do not modify accepted mixes or provide new mixes without the Engineer's prior review and acceptance of the proposed alternative.
    a. Exception: At all times, adjust batching of water to compensate for free moisture content of the fine aggregate used.
    b. For any change to approved mixes, the Engineer may require new trial batching and testing program as specified in this Section before acceptance and use.
    c. For any change to approved mixes, make modifications within limits set forth in this Section.
    d. If there is change in source or quality of any constituent of the concrete class or mix, the revised mix will be considered a new class of concrete and shall require full re-submittal of all data describing mix constituents, design, and testing.
6. Material sampling, mix designs, trial batch preparation and testing, modifications to mix designs, and any re-testing required to satisfy the requirements of this Section or to obtain satisfactory performance shall be at the Contractor's expense and shall not be considered cause for delay.

B. Measurements of materials:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
2. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
3. Accuracy of weighing devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within 1 percent of desired amount of that material.
4. Measuring or weighing devices: Subject to review by the Engineer. Shall bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing cementitious materials:
    a. Weigh cementitious materials separately.
    b. Cement in unbroken standard packages (sacks): Need not be weighed.
    c. Weigh bulk cementitious materials and fractional packages.
6. Measure mixing water by volume or by weight.

C. Requirements for mix proportioning:
1. Develop and provide mixes that:
    a. Can be readily worked into corners and angles of forms and around reinforcement, without excessive vibration, and without permitting materials to segregate or free water to collect on surface.
    b. Prevent unnecessary or haphazard changes in the consistency of the concrete supplied.
2. Constituent materials:
    a. Provide concrete mixes composed of Portland cement or blended cement, blended aggregates, admixtures and water.
        1) Admixtures required for each concrete class are indicated in Table 3 of this Section. Admixtures not specifically required by that table for a specific concrete class are optional and may be included at the discretion of the Contractor based on the Contractor's planned means and methods of construction.
    b. In no case shall returned fresh concrete or its constituents be incorporated into concrete batched for the Work.

3. Minimum specified compressive strength:
    a. Minimum specified compressive strength is designated at 28 days, unless otherwise indicated in Table 3 of this Section.
    b. For locations where the placed concrete is adequately protected and is not subjected to loads for an extended period during construction, the Contractor may request that the period for achieving the minimum specified compressive strength be extended to 56 days.
        1) If accepted by the Engineer, provide mixes that achieve at least 75 percent of their minimum specified compressive strength after 28 days.
4. Proportions and consistency:
    a. Ratio of water to cementitious materials, and cementitious materials content:
        1) Conform to maximum and minimum cementitious material content requirements specified in Table 3 of this Section.
        2) Cementitious materials content: Consisting of Portland cement or blended cement as indicated in Table 3 of this Section, plus supplemental cementitious materials if aggregate testing indicates potentially reactive aggregates:
            a) Fly ash content:
                (1) Minimum: 15 percent of the total weight of cementitious materials.
                (2) Maximum: 25 percent of the total weight of cementitious materials.
                (3) Class M: Provide 20 to 25 percent by weight of the total cementitious content as Class F fly ash.
            b) Slag cement content:
                (1) Minimum: 20 percent of the total weight of cementitious materials.
                (2) Maximum: 30 percent of the total weight of cementitious materials.
            c) Silica fume content:
                (1) Minimum: 4 percent of the total weight of cementitious materials.
                (2) Maximum: 10 percent of the total weight of cementitious materials.
    b. Aggregate size and content:
        1) Blend aggregates to produce an optimized gradation that combines well-graded coarse, intermediate, and fine aggregates in proportions that maximize the aggregate content of the mix, and that minimize the cement paste content of the mix.
            a) Percentage of individual fractions of the combined aggregate gradation retained on individual sieve sizes: Within the range shown in Attachment C - Combined Aggregate Gradation Chart (Tarantula Curve).
            b) Sum of the percentages of individual fractions retained on the No. 8, No. 16, and No. 30 sieves: Greater than 20 percent.
            c) Sum of the percentages of individual fractions retained on the No. 30, No. 50, No. 100, and No. 200 sieves: Within the range of 25 percent to 40 percent.

c. Determine bulk density and void content of the combined gradation of aggregates in accordance with ASTM C29. Results for combined aggregates shall not be the summation of results of testing of the individual gradations.
    1) Sample the combined aggregate from a flowing aggregate stream or conveyor in accordance with ASTM D75. Take care to ensure that the sample is representative of the proportions of the combined aggregate of the proposed mix.
    2) Reduce sample of combined aggregate to test sample size in accordance with ASTM C702, Method A - mechanical splitter or Method B - quartering.
    3) Perform bulk density test of combined aggregate in accordance with ASTM C29, Procedure A - rodding.
    4) Determine void content of the combined aggregate in accordance with ASTM C29, Procedure A - rodding. Specific gravity of the combined aggregate shall be determined in accordance with ASTM C136.

d. Paste content: Limited to the following:
    1) Class A mixes without air entrainment: Maximum 28 percent measured by volume.
    2) Class A mixes with air entrainment: Maximum 28 percent measured by volume plus the target air content.
    3) Paste content shall be limited to 175 percent of the void content of the combined aggregate gradation determined by ASTM C29.

e. Total water content:
    1) Not exceeding the water to cementitious material ratio specified in Table 3 of this Section.
    2) Not exceeding 245 pounds of water per cubic yard of concrete for Class A mix.

f. Coarseness/workability (Shilstone Method):
    1) Proportion mixes to fall into the “Optimal” zone (Zone II) when plotted on the Coarseness Factor Chart (“Coarseness Factor” versus “Workability Factor”) included as Attachment B - Coarseness Factor Chart to this Section. Provide plot for each Class A mix to be used in the Work.
    2) Coarseness factor (CF) for each mix shall be calculated as the percent of the combined aggregate gradation retained on the 3/8-inch sieve, divided by the percent of the combined aggregate gradation retained on the No. 8 sieve, multiplied by 100, or:

$$CF = \frac{(\%\ \text{retained on 3/8-in sieve})}{(\%\ \text{retained on No. 8 sieve})} \times 100$$

    3) Workability factor (WF) for each mix shall be the percent of the combined aggregate gradation retained on the No. 8 sieve, adjusted for cement content in the mix.
        a) Determine volume of total cementitious material in the mix.
        b) For each 94 pounds of cement content above 564 pounds per cubic yard, increase workability factor by 2.5 units.
        c) For each 94 pounds of cement below 564 pounds per cubic yard, decrease workability factor by 2.5 units.

d) Proportion adjustment factor by linear interpolation for each fraction of 94 pounds above or below the 564 pound basis.
e) Example:
650 pounds per cubic yard = 564 pounds + 86 pounds.
Adjustment = (86 lb / 94 lb) x 2.5 = + 2.28.

D. Concrete classes for use in the Work:
1. Provide concrete classes listed in Table 3 of this Section.
2. Provide normal weight concrete, having minimum weight of 140 pounds per cubic foot, unless otherwise noted.
3. Pumped concrete:
a. Provide pumped concrete that complies with all requirements of this Section.
b. Mixes placed by pumping shall be considered a sub class of each concrete class listed in Table 3 of this Section. Prepare and submit a separate mix design for each mix to be placed by pumping.
4. Class PM concrete: In addition to the requirements of Table 3 of this Section, conform to the following:
a. Minimum 28 day flexural strength: 650 psi when tested in accordance with ASTM C293.
b. Cementitious materials content: 75 percent Portland cement plus 25 percent Class F fly ash (by weight), blended cement conforming to 75 percent Type IL blended cement plus 25 percent Class F fly ash (by weight).
c. Aggregate:
1) Minimum 55 percent coarse aggregate conforming to ASTM C33 size number 357 or size number 467.
2) Substitute ASTM C33 size number 57, or size number 67 if mechanical paving equipment is not used.
5. Class M concrete: In addition to the requirements of Table 3 of this Section, conform to the requirements for Class A concrete.

Table 3. Concrete Classes

Concrete Class[1]	Minimum Specified Compressive Strength at 28 days, f'c [2] (pounds per square inch)	Ratio of water to cementitious materials[3] (minimum - maximum)	Cementitious Materials Content (pounds per cubic yard of concrete by weight)[4]	Cement Type	Maximum Chloride Content (percent by weight of cement)	Maximum Size of Coarse Aggregate (ASTM C33)	Air Entrainment (percent), (n/a: not applicable)	Admixtures required[4,5,6]	Slump Range (inches)
A	4,500	0.40 to 0.42	535 to 575	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS)	0.10	#57	6±1.5	AEA WRA	2 to 4

Table 3. Concrete Classes									
Concrete Class[1]	Minimum Specified Compressive Strength at 28 days, f'c [2] (pounds per square inch)	Ratio of water to cementitious materials[3] (minimum - maximum)	Cementitious Materials Content (pounds per cubic yard of concrete by weight)[4]	Cement Type	Maximum Chloride Content (percent by weight of cement)	Maximum Size of Coarse Aggregate (ASTM C33)	Air Entrainment (percent), (n/a: not applicable)	Admixtures required[4,5,6]	Slump Range (inches)
C	2,500	0.62 max.	423 min.	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS)	No limit	#57	6±1.5	AEA WRA	3 to 6
CE	3,000	0.62 max.	423 min.	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS)	No limit	#8	5±1.5	AEA WRA	3 to 6
PM	5,000	0.40	535 to 575	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS)	0.15	#57	5±1.5	AEA WRA	3 to 6
M	4,500	0.40 to 0.42	535 to 575	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS)	0.10	#4	6±1.5	AEA WRA	2 to 4

Notes:

(1) Sub classes within major concrete classes are designated as follows:
NA: Without air entrainment.

(2) At locations where concrete will not be subjected to load from other elements of the structure or from the Contractor's placing and/or backfilling operations, maximum time period for achievement of specified compressive strength may be extended to 56 days when accepted by the Engineer.

(3) W/C Ratio = Ratio of water to cementitious materials by weight. Include weight of admixtures in the water content of the mix when the quantity of the admixtures exceeds 10 ounces per 100 pounds of cement.

(4) Cementitious material includes Portland cement plus supplemental cementitious materials. If trial batch testing demonstrates that the required strength cannot be met at 28 or 56 days with the specified combined aggregate gradation and the paste content limits, cementitious material content may be increased with the Engineer's approval if Class M concrete is provided and Thermal Control Plan and Temperature Monitoring Program in accordance with Section 03_70_30 - Thermal Control of Concrete is provided for cast-in-place concrete elements. Cement content and/or threshold for the thermal control requirement may be adjusted by the Engineer based on the Equivalent Cement Content (ECC) of the approved Class M concrete mix.

(5) Admixtures are designated as follows:
AEA: Air entraining admixture.
PRAH: Permeability-reducing admixture for concrete exposed to hydrostatic conditions.
SRA: Shrinkage-reducing admixture.
WRA: Water-reducing admixture.

E. Install concrete classes in accordance with the following requirements, unless otherwise indicated on the Drawings.
   1. Class A concrete: Structural concrete.
      a. Use at all locations unless other Classes are specified or indicated on the Drawings.
   2. Class C concrete: Miscellaneous concrete fill and encasement.
      a. May be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
   3. Class CE concrete: Use for electrical conduit encasements.
   4. Class PM concrete: Use for concrete pavement, cart paths, curbs, gutters, and sidewalks.
   5. Class M concrete: Use at placements when the minimum dimension exceeds 36 inches or when the maximum specified cementitious material exceeds the limit in Table 3 and the minimum dimension exceeds 24 inches.

F. Concrete mix design documented by field experience:
   1. Mix design:
      a. Prepare preliminary mix design for each concrete class. Submit mix design with product and testing data for materials to be used in the mix for the Engineer's review.
   2. Historical records for similar mix.
      a. Determinations of similarity of materials and proportions between historical and proposed mixes shall be by the Engineer, and that shall be final.
      b. Historical record - Materials:
         1) Submit with each mix design the following data for a previously-supplied concrete mix similar to that proposed for this Work.
         2) Records demonstrating that the previously supplied mix included similar materials and proportions as those of the proposed mix.
            a) Documentation that the same concrete supplier will provide both mixes.
            b) Documentation that the materials used was from the same suppliers and had essentially the same properties, demonstrated by test data, as those proposed.
            c) Documentation that proportions of materials in the record mix are essentially the same as those proposed and that the specified compressive strength of the record mix is within 1,000 pounds per square inch of that required by this Section.
            d) Concrete supplier's statement describing any changes made to production of the record mix during the time period reported.
            e) Concrete supplier's statement that preparation and quality control procedures for the record mix were essentially the same as those to be employed for this Work.
      c. Historical record - Testing:
         1) Submit with each record mix, corresponding test data for slump, compressive strength (with relationships for rate of strength gain between testing ages), and drying shrinkage.
         2) Only records satisfying the following requirements will be accepted.
            a) All tests were conducted within a period of 1 year preceding the date of the Submittal.

b) All tests were conducted over a period including not less than 45 days.
c) Record of compressive strength testing includes at least 30 tests for slump and 28-day compressive strength.
d) Record of compressive strength tests is consecutive. In other words, it includes all tests conducted on the subject mix within the 1-year time period described above (not just selected tests during that period).
e) Submit concrete supplier's sworn statement confirming that all tests for the record mix have been reported.
f) Tests for drying shrinkage are described in subsequent paragraphs of this Section for "concrete mix design documented by trial batch preparation and testing".
g) Provide supplementary testing if requested by the Engineer.

d. For mixes determined to be similar and to have an acceptable test history, acceptance criteria shall be as follows:
1) Acceptance criteria:
a) Slump: All tests within limits specified for record mix.
b) Compressive strength: Average compression strength for tests, as determined by ACI CODE-350 not less than minimum required average strength.
c) Drying shrinkage: Within limits stated in subsequent paragraphs of this Section for "concrete mix design documented by trial batch preparation and testing".
d) Abrasion resistance: Within limits stated in subsequent paragraphs of this Section for "concrete mix design documented by trial batch preparation and testing".

G. Concrete mix design documented by trial batch preparation and testing:
1. Mix design and trial batches:
a. Prepare preliminary mix design for each concrete class. Submit mix design with product and testing data for each combination of materials and proportions to be used for the Engineer's review.
1) Determine water content of the mix based on curves showing the relation between water-cementitious materials ratio and the 7- and 28-day compressive strength of the concrete.
2) Determine each curve using 4 or more points, each representing the average compressive strength value of at least 3 specimens tested at each age.
b. After materials and proposed mix designs have been accepted by the Engineer, have trial batches for each concrete mix design prepared by the Contractor's testing laboratory.
1) Prepare trial batches using the cementitious materials, aggregates, and admixtures proposed to be used for the Work.
2) Provide batches of sufficient quantity to determine slump, workability, consistency, setting time, and finishing characteristics, and to provide sufficient specimens for testing.

c. For each trial batch, make and test specimens to determine and report slump, compressive strength (with relationships for rate of strength gain between testing ages), and drying shrinkage.
    1) If trial batches do not produce concrete conforming to the specified requirements for slump, strength, workability, consistency, drying shrinkage, restrained shrinkage, and finishing, change mix proportions and, if necessary, sources of materials.
    2) Make additional trial batches and perform additional tests until a batch that conforms to requirements of this Section is produced.

2. Testing - Slump:
    a. Determine slump in accordance with ASTM C143.
    b. Acceptance criterion: Slump within range specified.
3. Testing - Compressive strength:
    a. Prepare 4-inch diameter by 8-inch long cylinders in accordance with ASTM C31 for tests specified in this Section.
    b. Determine average compressive strength:
        1) Test at least 12 cylinders from each trial batch for compressive strength in accordance with ASTM C39.
        2) Test 4 cylinders at 7 days, another 4 at 28 days, and another 4 at 56 days.
        3) Calculate average compression strength for 7-day tests, for 28-day tests, and for 56-day tests.
        4) Calculate ratios for:
            a) Average 7 day strength to average 28 day strength.
            b) Average 28 day strength to average 56 day strength.
    c. Determine the required average compressive strength for each mix, f'cr, as described in the following paragraphs:
        1) Calculate required average compressive strength (f'cr) based on the minimum specified 28-day compressive strength, f'c, plus a standard deviation determined from the test history available for that mix.
        2) Determine f'cr as specified in ACI CODE-350, except as modified in the following paragraphs:
            a) Where 15 or more 28-day compressive strength tests are available, calculate standard deviation as described in the preceding paragraphs for "concrete mix design documented by field experience". Add this standard deviation to the specified minimum compressive strength to determine the required average compressive strength (f'cr) for the mix.
            b) Where fewer than 15 compressive strength tests at 28 days are available, determine minimum required compressive strength, (f'cr) from Table 4 of this Section.

Table 4. Required Average Compressive Strength, Fewer than 15 Tests Available

Minimum Specified Compressive Strength, f'c (pounds per square inch)	Required Average Compressive Strength, f'cr (pounds per square inch)
Less than 3,000	f'c + 1,000
3,000 to 5,000	f'c + 1,200
Over 5,000	f'c + 1,400

d. Acceptance criterion: Average compressive strength of the 4 cylinders tested at 28 days, or of the 4 cylinders tested at 56 days when permitted by the Engineer, shall equal or exceed the required average compression strength, f'cr for that concrete mix design.

4. Testing - Chloride content:
   a. Submit test results showing that the concrete mix contains water-soluble chloride ion content contributed from the constituents, including water, aggregates, cementitious materials, and admixtures is less than the limit specified in Table 3 of this Section. Test shall be performed in accordance with ASTM C1218 at age between 28 and 42 days.
5. Testing - Drying shrinkage - Prism specimens:
   a. Class A, Class M, and Class PM: From trial batch for each mix, prepare 10 drying shrinkage specimens in accordance with ASTM C157.
      1) Divide specimens into 2 groups of 5 specimens each: 1 group including shrinkage-reducing admixture and 1 group without shrinkage-reducing admixture.
   b. Prepare, cure, and test both groups in accordance with ASTM C157, except as modified in the following paragraphs.
      1) Remove drying shrinkage specimens from molds at age of 23 hours, plus or minus 1 hour, after trial batching.
         a) Immediately place them in lime-saturated water maintained at 73 degrees Fahrenheit, plus or minus 3 degrees, for at least 30 minutes.
         b) Remove specimens from the water and wipe with a damp cloth.
         c) Measure to nearest 0.0001 inch to determine original length.
         d) Record measurements and re-submerge specimens in lime-saturated water at 73 degrees Fahrenheit, plus or minus 3 degrees, for moist curing.
      2) Maintain submerged curing conditions at 73 degrees Fahrenheit, plus or minus 3 degrees, for 7 days. 7 days after batching, remove specimens from water and repeat measuring procedures.
      3) Immediately store specimens in a humidity controlled room maintained at 73 degrees Fahrenheit, plus or minus 3 degrees, and at 50 percent relative humidity plus or minus 4 percent for remainder of the test.
      4) At periods of 14, 21, 28, and 56 days after batching, remove specimens from curing room and repeat measurements.
   c. Drying shrinkage test report:
      1) Report measurements of all specimens at 1, 7, 14, 21, 28, and 56 days after batching.
      2) Using measured length at 7 days as base length for drying shrinkage, calculate the following for each measuring period:
         a) Drying shrinkage of each specimen. Determine as difference between the 7-day base length and measured length for each period.
         b) Average of these differences. If drying shrinkage of any specimen departs from the average of the measurements for each period by more than 0.0004 inch, disregard results obtained from that specimen.
         c) Percentage of drying shrinkage from batching to date of measurement.

d. Drying shrinkage acceptance criteria:
    1) Average shrinkage of trial batch concrete specimen group at 28 days after batching, when measured and cured as indicated, shall not exceed 0.035 percent.
e. Mixes accepted by the Engineer:
    1) Retain drying shrinkage test specimens. Bag in re-sealable plastic bags and submit to the Engineer.
    2) Indicate trial batch identifier, specimen number, and date of final measurements on each specimen bag.

2.07 SOURCE QUALITY CONTROL

A. Sample and test materials in accordance with the following requirements:
1. Sampling, testing, and reporting frequency:
    a. In preparation for mix design submittals and trial batch tests.
    b. Whenever there is a change in source of the material, or a significant change in the characteristics or quality of materials from the same source.
    c. For each 10,000 cubic yards of concrete mix produced.
    d. At intervals not exceeding 90 calendar days, unless otherwise specified in the following paragraphs.
2. Supplemental cementitious materials.
    a. Sample and test fly ash in accordance with ASTM C311.
    b. Sample and test slag cement in accordance with ASTM C989.
    c. Sample and test silica fume in accordance with ASTM C1240.
3. Aggregate:
    a. Sample combined aggregate in accordance with ASTM D75 and ASTM D3665, and test for gradation in accordance with ASTM C136.
    b. At least once every 30 days, and when requested by the Engineer.
    c. Submit test results.
4. Cementitious materials:
    a. Sample and test cementitious materials and provide mill certificates demonstrating compliance with ASTM C150 or ASTM C595, and additional requirements of this Section.
        1) Determine alkali content by method set forth in ASTM C114.
    b. At least once every 90 days, and when requested by the Engineer.
    c. Submit test results.

B. Batch materials in accordance with the following requirements:
1. Concrete batch weights: Control and adjust so as to secure maximum yield, and at all times maintain proportions of concrete mix within specified limits.
2. Aggregates:
    a. Obtain aggregate from a source capable of providing uniform quality, moisture content, and grading during any single day’s operation.
    b. Furnish satisfactory means at batching plant for checking moisture content of fine aggregate for each batch.
3. Admixtures:
    a. Batch solutions using mechanical batcher capable of accurate measurement.
    b. Air entraining admixture: Add to batch in portion of the mixing water, unless otherwise recommended by the admixture manufacturer.

PART 3 EXECUTION

3.01 PREPARATION

A. Prepare and submit mix designs for each concrete class indicated in Table 3 of this Section.

B. Submit proposed sequence of concrete placements. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested by the Contractor and accepted by the Engineer.
   1. Use construction methods and sequence work to allow concrete placement to reach adequate strength and to be constructed with required support to prevent overstress of the concrete structure during construction.

C. Make provisions for monitoring weather conditions:
   1. Install an outdoor weather station capable of measuring and recording ambient temperature, wind speed, and humidity. Furnish instruments accurate to within 2 degrees Fahrenheit, 5 percent relative humidity, and 1 mile per hour wind speed.
   2. Monitor the weather forecast beginning at least 48 hours prior to any concrete placement and make provisions for cold weather concreting or hot weather concreting if those conditions exist or are forecast to exist during the period of placement, finishing, and curing.
      a. Record temperature, relative humidity, and wind speeds for each placement beginning at least 24 hours before scheduled delivery of concrete.

D. Place no concrete without the Engineer's prior acceptance of conditions.

E. Notify the Engineer in writing that preparations are complete and ready for placement of concrete. Such notification shall indicate readiness - not just intention - to place concrete for the designated portion of the Work.
   1. Submit notification to the Engineer on forms provided by or acceptable to the Engineer and bearing the signature of the Contractor's superintendent.
      a. Sample form is included at the end of this Section, see Attachment B - Coarseness Factor Chart.
   2. Submittal of notification will be the Contractor's certification that preparations are complete and in accordance with the Contract Drawings and Specifications.
   3. Provide notification for the Engineer to make final observations at the locations of concrete placements not less than 24 hours before commencing placement of concrete.

3.02 CONCRETE JOINTS

A. Locations of joints are indicated on the Drawings.
   1. In order to preserve strength and watertightness of structures, make no other joints, except as authorized by the Engineer.
   2. Construct joints where indicated, and as indicated on the Drawings.
   3. Where joint locations are not indicated on the Drawings, submit the Contractor's proposed locations for the Engineer's review and acceptance. Provide construction joints in slabs and walls at intervals not greater than 35 feet.

B. Time between placements of adjacent concrete separated by joints.
   1. Provide not less than 3 days (72 hours) between placement of adjacent sections for the following:
      a. Slabs.
      b. Walls.
   2. Provide not less than 7 days (168 hours) between placement of the lower and upper pours for the following:
      a. Walls over slabs.
      b. Slabs over walls.
      c. Slabs keyed into the sides of walls.

C. Edges of joints:
   1. Provide joints have edges detailed as indicated on the Drawings.
   2. Protect wall and slab surfaces at edges from concrete splatter. Thoroughly clean adjacent surfaces after completion of each placement.

D. Joint construction:
   1. Preparation of forms:
      a. Provide cleanout holes at base of each wall and column for inspection and cleaning.
      b. Wash forms and adjacent joint surfaces of sawdust, chips, and other debris after forms are built, and immediately before concrete or grout placement.
      c. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use a vacuum cleaner for their removal and then flush cleaned surfaces with water.
   2. Before placing concrete against previously placed concrete, thoroughly clean the prior placement of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of pressure washing.
   3. Provide and install waterstops, expansion joint material, and other similar materials as indicated on the Drawings and as specified.
      a. Take special care to ensure that waterstops are secured in proper position.
      b. Take special care to ensure that concrete is well consolidated around and against waterstops during placement.
   4. Horizontal joints:
      a. As initial placement over cold joints, thoroughly spread bed of cement grout as specified in Section 03_60_00 - Grouting.
         1) Thickness: Not less than 1/2 inch or more than 1 inch.
      b. For wall placements above planned cold joints, placement of cement grout will not be required for locations where the wall mix includes high-range water-reducing admixture (superplasticizers), and the Contractor can demonstrate dense concrete joints without voids or honeycomb after the forms are removed.

3.03 MEASURING AND BATCHING MATERIALS

A. Measurements of materials:
   1. Proportion and measure cementitious materials and aggregates by weight.
      a. Weigh cementitious materials separately.

b. If bulk cementitious materials are used, weigh them on separate visible scale that will accurately register scale load at any stage of weighing operation from zero to full capacity.
c. Cement in unbroken standard packages (sacks) need not be weighed.

2. Mixing water: Measure by volume or by weight.
3. Other mix constituents: Measure by weight, except as otherwise specified or accepted by the Engineer.
4. Weighing and measuring devices:
   a. Use equipment designed and constructed specifically for that purpose.
   b. Furnish devices capable of weighing successive quantities of individual material measured to within 1 percent of desired weight of that material.
   c. Bearing valid seal of the department of weights and measures for the authority having jurisdiction over the Work.
5. Measurements and measuring devices:
   a. Subject to review by the Engineer.

B. Batching:
   1. Admixtures shall be added at the concrete batch plant.
   2. Addition of admixtures in the field is permitted only with prior acceptance by the Engineer, and only when the following conditions are satisfied:
      a. Dosage and mixing is personally overseen by the concrete supplier's trained technologist.
      b. Adequate mixing is provided after addition.
      c. Maximum time to placement of concrete remains 90 minutes after water added to mix - not 90 minutes after any field additions/adjustments.
      d. Slump at discharge after additions/modifications conforms to the requirements of Table 3 of this Section.

3.04 MIXING AND TRANSPORTING

A. Machine mixing:
   1. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer and ready for complete mixing with all mixing water.
   2. Procedure of mixing cementitious materials with sand, or with sand and coarse aggregate, for delivery to the Project Site for final mixing and addition of mixing water is not permitted.
   3. Remixing of concrete that has started to take its initial set (retempering) is not permitted.
   4. Discharge entire batch before recharging.
   5. Volume of mixed material per batch: Not exceeding manufacturer's rated capacity of mixer.

B. Transit-mixed concrete:
   1. Mix and deliver in accordance with ASTM C94, except as modified in this Section.
   2. Total elapsed time between addition of water at batch plant and discharging completed mix:
      a. Not to exceed 90 minutes or 300 revolutions of the mixing drum.
      b. Under conditions contributing to rapid setting, total elapsed time permitted may be reduced by the Engineer.

3. Temperature - minimum and maximum allowable during mixing and transporting:
    a. Minimum: 50 degrees Fahrenheit.
    b. Maximum: 90 degrees Fahrenheit.
4. Continuously revolve drum after it is started until it has completely discharged its batch.
    a. Do not add water until drum has started revolving.
    b. Engineer reserves the right to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. Contractor will not be entitled to additional compensation because of such increase or decrease.

C. Concrete delivery:
1. Furnish to the Engineer a delivery ticket for each batch of ready mixed concrete within 24 hours after delivery. Include the following information on each ticket:
    a. Time of day concrete was batched, and time of day that discharge from the truck is complete.
    b. Printed record of the individual weight of each of the following constituents in the batch: Fine aggregate, coarse aggregate, cement, pozzolan, and water.
    c. Concrete class as defined in Table 3 of this Section.
    d. Type, brand, and quantity of each admixture in the batch.
    e. Total volume of water allowed in the mix, volume of mixing water added at the batch plant, volume of mixing water withheld from the mix during batching, and total volume of any water added to the mix after leaving the batch plant.
        1) In no case shall volume of mixing water withheld result in a water/cementitious materials ratio less than the minimum values specified in Table 3 of this Section.
    f. Number of revolutions of transit truck at arrival on site, and total number of revolutions when discharge is complete.
    g. Volume of concrete delivered in the batch.
    h. Numerical sequence of the batch delivered for that placement.
2. Additional water may only be added to the mix when the following conditions are fully satisfied:
    a. Batch ticket showing total volume of water already added and maximum volume of water that may be added is available for the Engineer’s observation before any additional water is added.
    b. Total volume of water in the mix after the addition will be less than the maximum allowable volume of water indicated on the ticket.
    c. Full concrete load is still within the truck’s mixing drum, and truck has not begun to discharge the load. Under no conditions shall water be added in the field to a partial truckload of concrete.
    d. Volume of water added, and time of addition are clearly marked for record on the batch ticket delivered to the Engineer.
3. Addition of admixtures in the field is permitted only with prior approval by the Engineer, and when the following conditions are satisfied:
    a. Dosage and mixing is personally overseen by the concrete supplier’s trained technologist and the admixtures supplier’s representative.
    b. Adequate mixing time is provided after addition of admixtures.

c. Maximum time to placement of concrete remains 90 minutes after water is added to the mix - not 90 minutes after any field additions/adjustments.
d. Slump at discharge after additions/modifications conforms to the requirements of Table 3 of this Section.

D. Conveying concrete:
1. Convey concrete from mixer to location of final deposit by methods that prevent separation or loss of materials.
2. Use equipment for chutes, pumps, and conveying of concrete of such size and design as to ensure practically continuous flow of concrete, from delivery to the point of placement, without separation of materials.
3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day's placement.

3.05 PLACING AND CONSOLIDATING

A. Preparation:
1. Obtain the Engineer's acceptance of completed preparations before placing concrete.
a. Notify the Engineer in writing that all preparations are complete and ready for placement of concrete. Such indication shall indicate readiness, not just intention, to place concrete for the designated portion of the Work.
b. Submit completed Attachment D - Contractor's Concrete Placement Checklist Form.
2. Confirm completeness of the following before notification of readiness is given to the Engineer:
a. Place forms, reinforcement, screeds, anchors, ties, and inserts in final position.
b. Reinforcement is secure and properly fastened in its correct position.
c. Loose form ties at construction joints have been retightened.
d. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored to maintain a minimum 2-inch clearance between the item and any concrete reinforcement.
1) Securing embedded items in position by wiring or welding to the reinforcement is not permitted.
e. Forms have been cleaned of debris and form release agents are applied as specified.
3. Preparation for placement of footings and slabs on grade:
a. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the Engineer.
b. If necessary, sprinkle subgrade with water not less than 6 or more than 20 hours in advance of placing concrete.
c. If subgrade surface becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
d. Do not place concrete if subgrade is muddy or soft.

4. Keep sufficient protective coverings on hand at all times for protection of concrete during and after placement.
    a. Protect concrete placed before rain to prevent water from coming in contact with such concrete.
    b. Protect concrete placed before winds to prevent excessive drying or embedment of debris in the finished surfaces.

B. Concrete placement:
1. Do not place concrete:
    a. With slump outside the limits specified in Table 3 of this Section.
    b. In which initial set has occurred, or that has been retempered.
    c. During rainstorms or high velocity winds.
2. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
    a. Do not deposit concrete in large quantities in one place, and then work material along forms with vibrator or by other methods.
3. Do not drop concrete freely into place from height greater than 5 feet. Use tremies for placing concrete where drop is over 5 feet.
4. Place concrete on slopes starting from bottom of slope and working upward.
5. Place concrete in horizontal lifts not exceeding 24 inches in depth and bring up evenly in all parts of forms.
6. After concrete placement begins, continue in a continuous operation without significant interruption until the end of the placement. Plan and implement precautions to prevent any delay, between layers or adjacent volumes, from exceeding 20 minutes.
7. If concrete is to be placed over previously placed concrete and more than 20 minutes has elapsed, spread layer of cement grout over surface before placing additional concrete. Provide grout layer thickness of not less than 1/2 inch or more than 1 inch.
8. Placement of concrete for slabs, beams, or walkways:
    a. If cast monolithically over walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
    b. Allow set time of not less than 1 hour for shrinkage.
        1) During waiting time, keep top surface of concrete moist, but not wet.
        2) Do not permit water to pond or stand on the surface.
        3) Do not coat surface with evaporation retarders or curing agents.
    c. Start placement above wall or column with layer of cement grout as described in the preceding paragraph.

C. Consolidating concrete:
1. Consolidate concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the Work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
    a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
    b. In addition to vibrators in actual use while concrete is being placed, have on hand a minimum of 1 spare vibrator in operable condition.
    c. Do not place concrete until it has been confirmed that all vibrating equipment, including spares, are in operable condition.

5. Place concrete solidly against forms and concrete surfaces, leaving no voids or honeycomb.
6. Make concrete solid, compact, and smooth. If for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the Engineer.
7. Do not over-vibrate so as to produce segregation.

3.06 FINISHING CONCRETE

A. Provide concrete finishes in accordance with Section 03_35_29 - Concrete Finishes, unless otherwise indicated on the Drawings.

B. Liquid evaporation retardant:
   1. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, coat the surface of the concrete with a liquid evaporation retardant immediately after screeding.
   2. Conditions that result in rapid evaporation of moisture are defined as any combination of ambient temperature, concrete temperature, relative humidity, wind speed, and solar radiation intensity that creates conditions that will evaporate water from a free concrete surface at a rate equal to or greater than 0.1 pounds per square foot per hour as determined by the Menzel Formula and nomograph published in ACI PRC-305 and included as Attachment A - Menzel Formula and Nomograph to this Section.
   3. Apply evaporation retardant again after each finishing operation as necessary to prevent drying shrinkage cracks.
   4. Do not work evaporation retardant into the surface of the concrete.
   5. Do not use evaporation retardant as finishing aid (to rehydrate surface a creamy state for finishing).

C. Concrete sealer:
   1. Floors and slabs to receive concrete sealer: See Room Finish Schedule on the Drawings, and Section 03_35_29 - Concrete Finishes.

D. Surface-applied crystalline coating:
   1. Apply surface-applied crystalline coating in strict accordance with the manufacturer’s directions.
   2. Spray, squeegee or roll on liquid to clean, dry concrete surface at 225 square feet per gallon.
      a. Scrub liquid into the surface with a mechanical scrubber.
      b. Keep surface wet for a minimum of 30 minutes with the surface-applied crystalline coating during application.
      c. When the product thickens, but not more than 60 minutes after initial application, squeegee or vacuum the surface to remove all excess liquid.
      d. Do not leave any residue on surface.
      e. Do not track material on to untreated surfaces.
   3. Where concrete continues to sweat or leak, apply additional coats of surface-applied crystalline coating until the sweating or leaks stop.

3.07 CURING

A. Cure concrete by methods specified in this Section.

B. For placements of Class M concrete, as specified in Section 03_70_30 - Thermal Control of Concrete for additional requirements.

C. Cure period: Keep concrete continuously moist and at an average daily temperature of at least 50 degrees Fahrenheit for a minimum of 14 days after placement.
   1. If hourly temperatures at any surface of a concrete placement drop below 50 degrees Fahrenheit during the curing period, count the period below 50 degrees Fahrenheit as zero degrees, and extend the curing time to compensate.

D. Schedule of curing methods:
   1. Cure the following concrete surfaces using water curing or plastic membrane curing.
      a. Floor surfaces of water containment structures.
      b. Surfaces where additional concrete will be placed over or against the surface, including concrete joints.
      c. Surfaces where grout or other toppings will be placed over the surface.
      d. Slabs scheduled to receive concrete sealer, or other bonded or adhered architectural finishes.
      e. Formed surfaces scheduled to receive coatings, paint, adhered masonry, cementitious materials, or other similar finishes, and where formwork is removed within the specified cure period after concrete placement.
      f. Horizontal concrete surfaces at tops of walls.
   2. Cure the following concrete surfaces by water curing, plastic membrane curing, or sprayed curing membrane. Selection of methods shall be at the Contractor’s option.
      a. Surfaces not listed in the preceding paragraph.

E. Water curing:
   1. Keep surfaces of concrete constantly and visibly wet, day and night, for not less than the specified cure period.
      a. Each day forms remain in place will be counted as 1 day of water curing.
      b. Do not loosen form ties during period when concrete is cured by leaving forms in place. No further curing credit will be allowed for forms remaining in place after contact has been broken between concrete surface and forms.
   2. Begin water curing as soon as concrete attains initial set.
   3. Maintain a wet surface by ponding, continuous sprinkling, covering with saturated burlap, or otherwise saturating the surface by means acceptable to the Engineer.
      a. Flood top of walls with water at least 3 times per day and keep surfaces moist at all times during the curing period.
      b. Provide plastic sheet material over surfaces if required to maintain a wet surface during arid or windy conditions. See plastic membrane curing requirements for additional details.
   4. Use water having a temperature within 20 degrees Fahrenheit of the temperature of concrete, and not lower than the minimum temperature allowed for the concrete surface during curing.

F. Plastic membrane curing:
   1. Install plastic membrane as soon as concrete is finished and can support limited pedestrian traffic without damage.
   2. Cover entire surface of finished concrete with membrane.
   3. Anchor membrane to prevent uplift from wind or air trapped below the sheet.
   4. Fully seal joints and edges to provide full seal around perimeter.
   5. Keep concrete under plastic membrane moist, regularly monitoring surfaces and adding supplemental moisture if necessary. Add water as specified for water curing.

G. Sprayed membrane curing compound:
   1. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
      a. If more than 1 hour elapses after removal of forms, do not use membrane curing compound. Instead, provide water curing for not less than the specified cure period.
      b. Do not remove sprayed membrane curing compound from concrete before the end of the specified cure period.
      c. When application of curing compound at concrete joints is accepted by the Engineer, take care to apply curing compound to all surfaces along full profile of joints.
   2. Apply curing compound by mechanical, power operated sprayer with mechanical agitator that will uniformly mix all pigment and compound.
      a. Apply curing compound in at least 2 coats. Each coat shall be applied at the manufacturer's recommended application rate.
      b. Apply each coat in direction turned 90 degrees from application direction of the preceding coat.
      c. Apply curing compound in sufficient quantity so that concrete has uniform appearance and its natural color is effectively and completely concealed immediately after spraying. This requirement may require additional coats and/or application rates than indicated above.
      d. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
   3. Thickness and coverage of curing compound:
      a. Provide curing compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
      b. Contractor is cautioned that method of applying curing compound specified in this Section may require more curing compound than normally suggested by manufacturer of curing compound and is more than is customary in the trade. Apply amounts specified in this Section, regardless of manufacturer's recommendations or customary practice.
   4. If the Contractor desires to use a curing compound other than specified product, coat sample areas of concrete wall with proposed curing compound, and also coat similar adjacent area with the specified compound in the manner specified, for comparison:
      a. If proposed sample is not equal or better, in the opinion of the Engineer, the proposed substitution will not be allowed.
   5. Removal of curing compound.
      a. After curing period is complete, remove curing compound placed on surfaces that will receive additional concrete, including all concrete joint surfaces, by heavy sandblasting or by other means acceptable to the

Engineer. Complete removal and cleanup prior to placing any new concrete against the surface.

b. Where additional finishes will be applied over concrete surfaces, unless otherwise recommended by the manufacturer of the finish to be applied, remove curing compound by sandblasting. Provide blasting as necessary to fully remove curing compound.

6. Prior to final acceptance of the Work, remove, by sandblasting or by other method acceptable to the Engineer, any curing compound on surfaces exposed to process water or exposed to view, so that only natural color of finished concrete is visible and uniform over the entire surface.

3.08 PROTECTION

A. General:
   1. Keep forms in place, as specified in Section 03_11_07 - Concrete Formwork, to provide curing and to protect concrete surfaces and edges from damage.
   2. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified.

B. Loading of concrete members:
   1. Placement of loads on or against green concrete is not permitted.
   2. Do not place soil against walls, or fill over the top of concrete until conditions designated in the following paragraphs are satisfied:
      a. Walls have been cast to their full height in the structure and have achieved their minimum specified 28-day compressive strength.
      b. Connecting slabs and beams that brace the walls are in place, are complete, and (in the case of concrete) have achieved their minimum specified 28-day compressive strength.

3.09 COLD WEATHER CONCRETING

A. Implement cold weather concreting procedures during periods of cold weather as defined in this Section.
   1. Comply with the recommendations of ACI PRC-306 and this Section.

B. Prepare a cold weather concreting plan. Maintain at least 1 copy of the plan on site. Provide plan for review if requested by the Engineer.
   1. Include procedures for batching, delivery, placement, curing, protection, and for monitoring and recording the temperature of the concrete and the surrounding environment.
   2. Describe procedure to be implemented in the event of abrupt changes in weather conditions or of equipment failure.
   3. Review cold weather concreting plan during pre-construction meeting. Make provisions to address any concerns expressed by the Engineer before beginning concrete placements.

C. Preparation:
   1. Do not place concrete over frozen subgrade materials. Provide insulating material and supplementary heat if required to maintain a thawed surface.

2. Do not place concrete around metallic elements whose temperature is less than 40 degrees Fahrenheit. If heating is required, use processes that do not alter the metallurgical properties of the elements.
3. Remove snow, ice, and frost from reinforcement, embedments and forms. Schedule such removal immediately before concrete placement so that surfaces do not refreeze.

D. Batching, delivery, placement and finishing:
   1. Accelerating admixtures will not be permitted.
   2. Based on temperature of the environment and the surfaces where concrete will be placed, select and maintain mix temperature as recommended in ACI PRC-306.
      a. Make provisions for temperature loss during delivery and placing.
      b. Place concrete at or slightly above the minimum recommended batch temperatures. Do not exceed these minimum values by more than 20 degrees Fahrenheit.
   3. Heating: If temperature of water or aggregates is below 35 degrees Fahrenheit, heat the materials.
      a. Mixing water: Do not heat above 140 degrees Fahrenheit.
      b. Aggregates:
         1) Heat uniformly to eliminate ice, snow, and frozen lumps of material.
         2) Avoid overheating.
         3) Do not exceed average temperature of 140 degrees Fahrenheit or spot temperature of 200 degrees Fahrenheit.

E. Protection and curing:
   1. Protect concrete to provide continuous warm moist curing immediately after placement and during protection period.
   2. Minimum protection period: until concrete reaches specified minimum compressive strength.
   3. For placements of Class M concrete, do not use steam or other concrete heating methods that will increase concrete temperature outside the limits of Section 03_70_30 - Thermal Control of Concrete.
   4. During and immediately after the protection period, maintain temperature in accordance with Table 5 of this Section. Provide record of temperature during placement and curing as specified in the following paragraphs.
      a. Furnish and locate maximum/minimum temperature recording thermometers in sufficient numbers to confirm concrete.

Table 5. Concrete Temperatures - Normal Weight Concrete

Section Thickness (inches)	<12	12 to <36	36 to <72
During Protection Period: As maintained (minimum)	55°F	50°F	45°F
After Protection Period: Gradual drop during first 24 hours (maximum)	50°F	40°F	35°F

5. Provide plastic sheeting, polystyrene foam sheets, insulating blankets, and supplemental heating if required to maintain moisture and the specified temperatures during protection.
    a. Protect insulating blankets from moisture in the concrete and from rain or snow using impermeable sheeting.
    b. Supplemental heating units:
        1) Vent units to outside atmosphere. Do not exhaust heater flue gasses into the enclosed and protected area.
        2) Make provisions to heat the flow freely within protected area, and to maintain a uniform temperature throughout the space.
        3) Locate units to avoid local drying or uneven heating of concrete surfaces.
    c. Pay particular attention to maintaining required temperature and moisture at edges and corners.
6. At the end of the protection period, allow concrete to cool gradually to the ambient temperature.
    a. Maximum temperature drop over the first 24-hour period shall be as specified above.
    b. Where temperature of concrete exceeds ambient by 20 degrees Fahrenheit or more, loosen forms and leave in place for at least 24 hours before removal.
    c. If water curing has been used, maintain concrete temperature as specified in the following paragraphs for at least 24 hours after water curing is terminated. Allow water-cured concrete to air dry for at least 3 days before exposure to freezing temperatures.

F. Temperature records:
1. For each area of concrete placed or cured during cold weather, record the temperature of concrete and the ambient environment.
    a. Maintain temperature records on site and make records available for review by the Engineer upon request.
    b. Deliver a final copy of each record to the Engineer for Project files not more than 14 calendar days after the date concrete was placed.
2. Concrete delivered for placement.
    a. Measure and record temperature at the point of discharge in accordance with ASTM C1064.
    b. Note temperature on the batch ticket.
3. Concrete during the protection period:
    a. Furnish and locate self-recording thermometers (maximum/minimum) around each placement. Number and location of thermometers shall be sufficient to represent temperatures around the entire concrete placement.
    b. Position thermometers to record the temperature at each edge or corner and at the middle of the placement area.
4. Include in the temperature record of each placement the following information, recorded legibly on a single sheet.
5. In the event that evaluations of the efficacy of concrete protection and curing are required, the lowest temperature recorded in any placement during each 24-hour period will be assumed to be the temperature at which the entire placement was maintained. Protection periods with any temperature records will be assumed to have provided no protection or curing, and the protection period will be extended by 2 days for each day without protection.

3.10 HOT WEATHER CONCRETING

A. Implement hot weather concrete procedures during periods of hot weather as defined in this Section.
   1. Comply with the recommendations of ACI PRC-305 and this Section.

B. If placements during hot weather are expected, and when requested by the Engineer, prepare a hot weather concreting plan.
   1. Maintain at least 1 copy on site.
   2. Provide plan for review if requested by the Engineer.
      a. Include procedures for batching, delivery, placement, curing, protection, and monitoring and recording the temperature of the concrete and the surrounding environment.
      b. Describe procedures to be implemented in the event of abrupt changes in weather conditions, or in the event of equipment failure.
      c. Review hot weather concreting plan during pre-construction meeting. Make provisions to address any concerns expressed by the Engineer before beginning concrete placements.

C. Preparation:
   1. Do not place concrete against forms, reinforcement, or embedments with a surface temperature greater than 120 degrees Fahrenheit.
      a. If necessary, to maintain maximum concrete temperature during placing, cool forms and reinforcement to temperature below 90 degrees Fahrenheit using water or shades.
      b. Do not allow water to puddle in forms or placement areas.
   2. Moisten forms or subgrade to maintain a saturated surface without standing water or soft spots.
   3. Provide windbreaks, shades, fog spray, sprinkling, wet cover, or other means required to protect concrete from premature loss of moisture and rapid temperature gain.

D. Batching and delivery:
   1. Retarding admixtures will not be permitted.
   2. Temperature of concrete delivered for placement shall not exceed 90 degrees Fahrenheit.
      a. Maintain uniform temperature in the mix below this level during batching, delivery, placing, and consolidation.
      b. Temperature of mix, even if below the maximum allowable temperature specified, shall be maintained at a level to avoid loss of slump, flash setting, or cold joints in placements.
   3. If necessary:
      a. Mix water may be chilled or replaced with ice to maintain mix temperature. Where mix water is replaced with ice, provide replacement at a 1-to-1 ratio by weight.
      b. Shade transit mixed concrete trucks, or cool mixing outside of container with water to control temperature of concrete.

E. Placing and finishing:
   1. Place and finish concrete promptly. Place so that vertical lift lines will not be visible in exposed concrete surfaces.

2. Provide plastic sheeting, fog nozzles, shades or other means to reduce concrete temperature and protect from moisture loss.
3. For placements of Class M concrete, use fog sprayers to reduce ambient air temperature and increase humidity during concrete placement.

F. Protection and curing:
1. Furnish and locate maximum/minimum temperature recording thermometers in sufficient numbers to confirm concrete temperatures over full area and edges of concrete.
2. Flatwork: Protect and cure using water curing methods as specified in this Section.
   a. Water curing:
      1) Keep concrete continuously wet and make provisions for runoff.
      2) For sprinkling or soaker hoses, maintain temperature of water as close as possible to the temperature of the concrete to minimize effects of thermal shock.
3. Formed surfaces: Protect and cure using forms left in place or membrane curing methods as specified in this Section.
   a. Cover forms and keep continuously moist for at least 24 hours after placement.
   b. Loosen forms as soon as this can be accomplished without damaging the concrete.
   c. Maintain continuously moist surfaces by fogging or spraying with water, or by application of curing compound as specified.

3.11 FIELD QUALITY CONTROL BY CONTRACTOR

A. Provide quality control over the Work of this Section as required by Section 01_45_00 - Quality Control.

B. Temperature Monitoring Program:
1. For placements of Class M concrete, execute temperature monitoring program required in Section 03_70_30 - Thermal Control of Concrete.

C. Field tests:
1. During progress of construction, provide testing to determine whether the concrete, as being produced, complies with requirements specified.
2. Sampling and testing shall be performed by the Contractor's testing laboratory. See Section 01_45_24 - Regulatory Quality Assurance - Special Tests and Inspections for requirements.
   a. Cooperate in testing by allowing free access to the Work for testing laboratory to sample and test materials.
   b. Provide full access for the Engineer to observe concrete sampling and testing at any time.
   c. Contractor is responsible for providing care of and curing conditions for test specimens in accordance with ASTM C31 until specimens are collected by testing laboratory.
   d. Provide 4 firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold 10 specimens. Include cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication through shipment to the Owner's testing laboratory.

3. Testing shall include:
    a. Sampling of concrete in accordance with ASTM C172.
    b. Temperature of concrete at delivery in accordance with the requirements of ASTM C1064 and as specified in this Section.
    c. Slump of concrete using slump cone in accordance with requirements of ASTM C143. Test slump at the following intervals:
        1) At the beginning of each placement.
        2) As often as necessary to keep slump within the specified range, but not less than every 6th truck.
        3) When requested to do so by the Engineer.
        4) Observe concrete during slump test for signs of segregation.
            a) Observe concrete to see if mortar or moisture flows from slumped concrete.
            b) Reject concrete if mortar or moisture flows out of mix.
    d. Unit weight of concrete in accordance with ASTM C138.
    e. Air entrainment in accordance with ASTM C173. Test air content at the following intervals:
        1) At beginning of each placement.
        2) As often as necessary to keep entrained air within specified range, but not less than every 6th truck.
        3) When requested to do so by the Engineer.
        4) Test air entrainment in concrete in accordance with ASTM C173. If air entraining admixtures used for the Work require alternate testing procedures, advise the independent testing laboratory well in advance of the dates of testing, and confirm that appropriate equipment and personnel are provided for the test.
        5) Make air test at point of delivery (discharge from mixer). For pumped concrete, make air tests at point of delivery and at point where expelled after pumping for placement.
    f. Compressive strength in accordance with ASTM C39. Required number of cylinders is as follows:
        1) Not less than 6 cylinder specimens, 4 inches in diameter by 8 inches long, will be tested for each 100 cubic yards of each class of concrete or 5,000 square feet of slab or wall, with minimum of 6 specimens for each class of concrete placed; not less than 6 specimens for each half day's placement; and not less than 2 sets of 6 specimens for each structure.
        2) 1 cylinder will be broken at 7 days, 1 at 14 days, and 3 at 28 days. 6th cylinder may be used to evaluate strength after 28 days if requested by the Engineer.
        3) Retain and store 6th cylinders (tested and untested) at testing laboratory until 56 days. Break 6th cylinder when directed by the Engineer.
    g. Provide full access for the Engineer to observe concrete sampling and testing at any time.

D. Test completed liquid containment structures listed in Section 01_75_19 - Water Leakage Test for Concrete Structures for watertightness.

3.12 FIELD QUALITY CONTROL BY OWNER

A. As specified in Section 01_45_00 - Quality Control.

B. Special tests and inspections: As specified in Section 01_45_24 - Regulatory Quality Assurance.

C. Field inspections:
   1. Observe construction for conformance to the Contract Documents and the accepted submittals.
   2. Records of inspections:
      a. Provide a record of each inspection.
      b. Submit copies to the Contractor upon request.

D. Field tests:
   1. Engineer may request, at any time, additional testing to confirm materials being delivered and placed conform to the requirements of the Contract Documents.
      a. If such additional testing shows that the material do not conform to the specified requirements, the Contractor shall pay the cost of these tests.
      b. If such additional testing shows that the materials do conform to the specified requirements, the Owner will pay the cost of these tests.

3.13 NON-CONFORMING WORK

A. Remove and replace or repair non-conforming and defective work.
   1. Provide repairs having strength equal to or greater than specified concrete for areas involved.
   2. Provide replacement or repair of non-conforming work by means acceptable to the Engineer and at no additional cost to the Owner.
   3. Project schedule will not be extended based on work to address non-conforming concrete.

B. Concrete not conforming to the specified requirements for properties of plastic concrete: Remove from the Site and replace with conforming materials at no additional cost to the Owner.
   1. Temperature: Do not use concrete having a temperature above or below the limits specified in this Section.
   2. Slump: Do not place concrete that does not conform to requirements for slump.
   3. Air entrainment: Do not use concrete that does not conform to requirements for percentage of entrained air.

C. Concrete not conforming to the specified requirements for compressive strength:
   1. Concrete is expected to reach a compressive strength equal to or greater than the minimum specified compressive strength f’c in Table 3 of this Section.
   2. Strength of concrete will be considered acceptable if the following conditions are satisfied.
      a. Averages of all sets of 3 consecutive strength test results is greater than or equal to the specified compressive strength f’c.
      b. No individual strength test (average of 3 cylinders) falls below the strength specified in Table 6 of this Section.

c. Where relationships between 7-day and 28-day compressive strength, or between 28-day and 56-day compressive strength, have been provided as part of the mix design submittals:
   1) 7-day strength may be considered as an indication of 28-day strength provided effects of temperature and humidity between 7 days and 28 days are taken into account.
   2) 28-day strength may be considered as indication of 56-day strength provided effects of temperature and humidity between 28 days and 56 days are taken into account.

Table 6. Strength Compliance Requirements	
Minimum Specified Compressive Strength, f'c (pounds per square inch)	**Lower Bound of an Individual Compressive Strength Test (pounds per square inch)**
Less than 5,000	f'c - 500
Over 5,000	f'c - (0.10 x f'c)

3. Non-compliant strength tests.
   a. Mark non-compliant strength test reports to highlight the non-complying results, and immediately forward copies to all parties on the test report distribution list.
   b. Initial treatment may consist of additional curing of affected portion(s) followed by not less than 3 cores at each affected area, taken in accordance with ASTM C42 and ACI CODE-318. Obtain the Engineer's acceptance of proposed coring locations before proceeding with that work.
   c. Submit report of compressive strength testing for the Engineer's review.
   d. If requested by the Engineer, provide additional cores, and obtain petrographic testing in accordance with ASTM C856. Submit results for the Engineer's review.
   e. If additional curing does not bring the average strength of 3 cores taken in affected area to at least specified compressive strength f'c, designate such concrete in affected area will be considered defective.
   f. Engineer may require the Contractor to strengthen defective concrete by means of additional concrete, additional reinforcing steel, or replacement of defective concrete, all at the Contractor's expense.

D. Concrete sections or surfaces with honeycombing and voids:
   1. Provide repairs having surface appearance and finish consistent with that of the surrounding work and acceptable to the Engineer.
   2. Do not patch, repair, or cover defective work without prior inspection by the Engineer.
   3. Preparation of concrete for repair:
      a. Make no repair until the Engineer has accepted methods for preparing surfaces and for making and curing repairs.
      b. Chip out and key-in imperfections in the Work to make them ready for repair.
      c. Coat bonding surfaces and edges of repair area with one of the following bonding agents as accepted by the Engineer.
         1) Epoxy bonding agent as specified in Section 03_63_01 - Epoxies; or,
         2) Epoxy resin/Portland cement bonding agent as specified in Section 03_63_02 - Epoxy Resin/Portland Cement Bonding Agent.

4. Methods of repair:
    a. Dry pack mortar method:
        1) Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt holes, and for narrow slots cut for repair.
        2) Smooth holes: Clean and roughen by heavy sandblasting before repair.
        3) Install dry-pack mortar as specified in Section 03_60_00 - Grouting.
    b. Cement mortar method:
        1) Use for holes too wide to dry pack and too shallow for concrete replacement; and for comparatively shallow depressions, large or small, that extend no deeper than nearest surface reinforcement.
        2) Install cement mortar as specified in Section 03_60_00 - Grouting.
    c. Concrete replacement:
        1) Use when holes extend entirely through the concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.
        2) Form, place, consolidate, and cure concrete of same mix as the surrounding work.

E. Leaking construction joints and cracks in concrete walls and slabs:
    1. Repair cracks that develop in walls or slabs, and repair cracks that show any signs of leakage until all leakage is stopped.
    2. Pressure inject visible cracks in the following areas, other than hairline cracks and crazing, with repair products and methods acceptable to the Engineer.
        a. Floors and walls of water bearing structures.
        b. Walls and overhead slabs of passageways and occupied spaces where the opposite face of the member is exposed to weather or may be washed down and where the opposite face does not receive a separate waterproofing membrane.
        c. Other items not specified to receive separate waterproofing membrane, including slabs over water channels, wet wells, reservoirs, and other similar surfaces.
    3. Continue pressure injection of cracks as specified until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion or date of final repair, whichever occurs later in time.

F. Leaking expansion joints in concrete walls or slabs that include waterstops:
    1. Repair any signs of leakage until all leakage is stopped.
    2. Pressure inject visible leaks with hydrophilic polyurethane foam resin as specified in Section 03_64_25 - Hydrophilic and Hydrophobic Foam Polyurethane Resin Injection System.
    3. Continue pressure injection along joints lines as specified until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion or date of final repair, whichever occurs later in time.

G. Walls and slabs at overhead channels that leak or sweat because of porosity or cracks too small for successful pressure injection with epoxy.
    1. Seal on water or weather side by coating using surface-applied crystalline coating as specified in this Section.

2. Apply as recommended by manufacturer published instructions. Where concrete continues to sweat or leak, apply additional coats of surface-applied crystalline coating until the sweating or leaks stop.
3. Continue application of surface-applied crystalline coating until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion, or date of final repair, whichever occurs later in time.

END OF SECTION

ATTACHMENT A - MENZEL FORMULA AND NOMOGRAPH

MENZEL FORMULA AND NOMOGRAPH

Source: ACI PRC-305

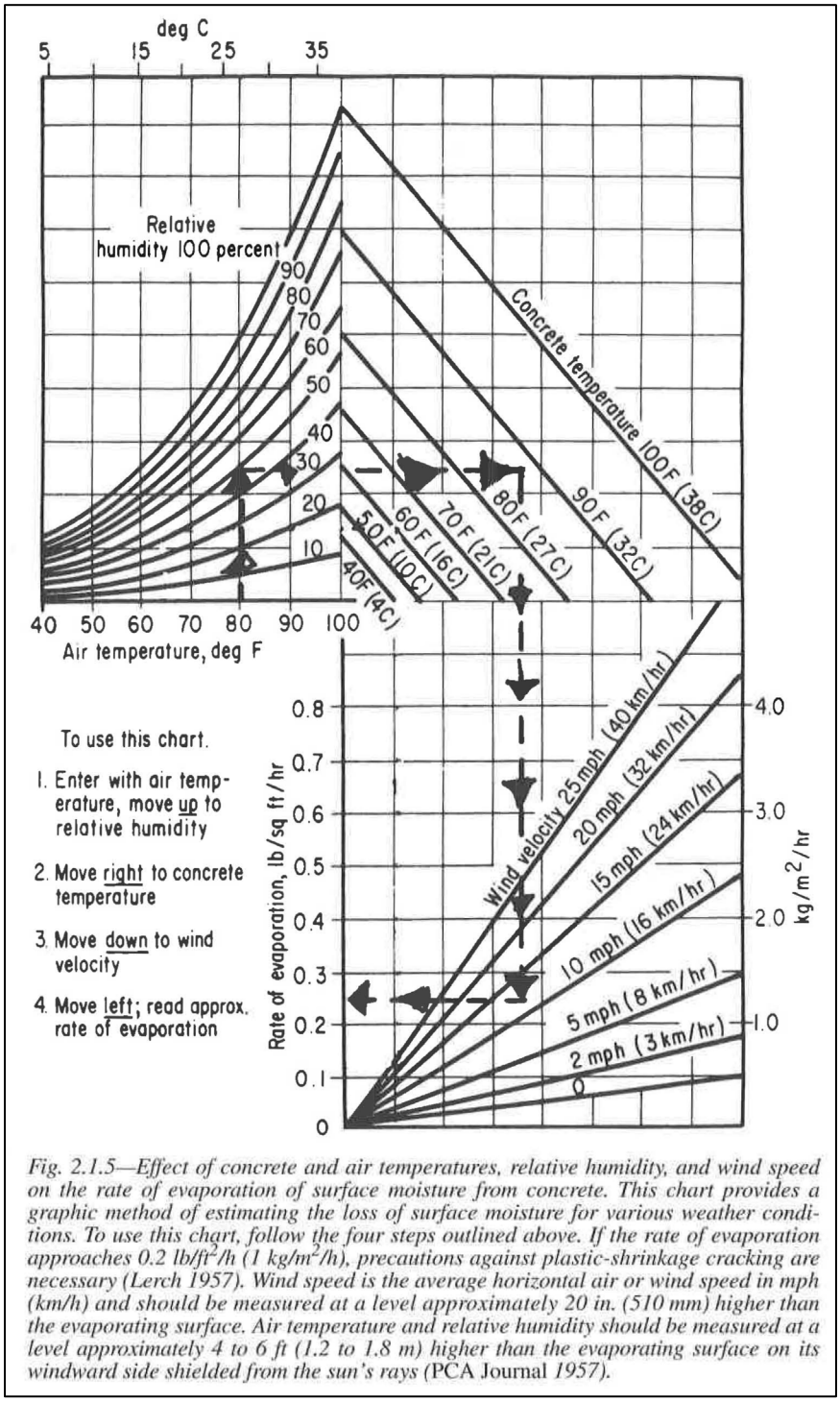


*Fig. 2.1.5—Effect of concrete and air temperatures, relative humidity, and wind speed on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use this chart, follow the four steps outlined above. If the rate of evaporation approaches 0.2 lb/ft²/h (1 kg/m²/h), precautions against plastic-shrinkage cracking are necessary (Lerch 1957). Wind speed is the average horizontal air or wind speed in mph (km/h) and should be measured at a level approximately 20 in. (510 mm) higher than the evaporating surface. Air temperature and relative humidity should be measured at a level approximately 4 to 6 ft (1.2 to 1.8 m) higher than the evaporating surface on its windward side shielded from the sun's rays (*PCA Journal *1957).*

ATTACHMENT B - COARSENESS FACTOR CHART

COARSENESS FACTOR CHART

Source: ACI PRC-302.1-15, Figure 8.9.2.2.

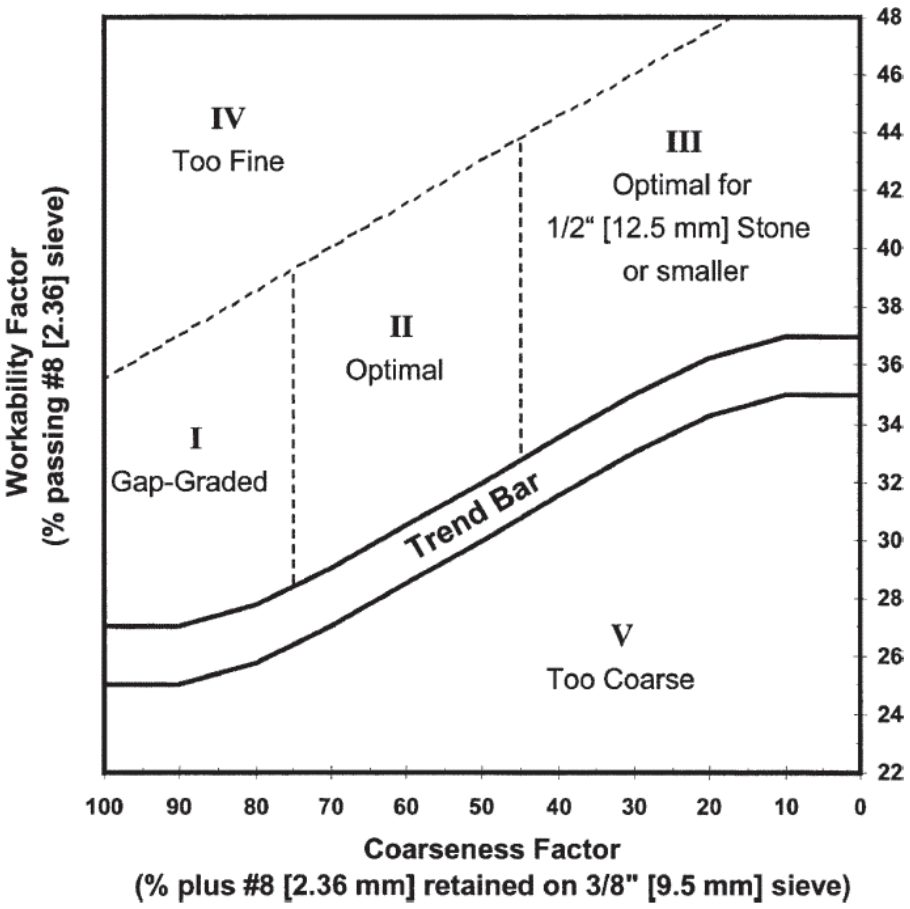
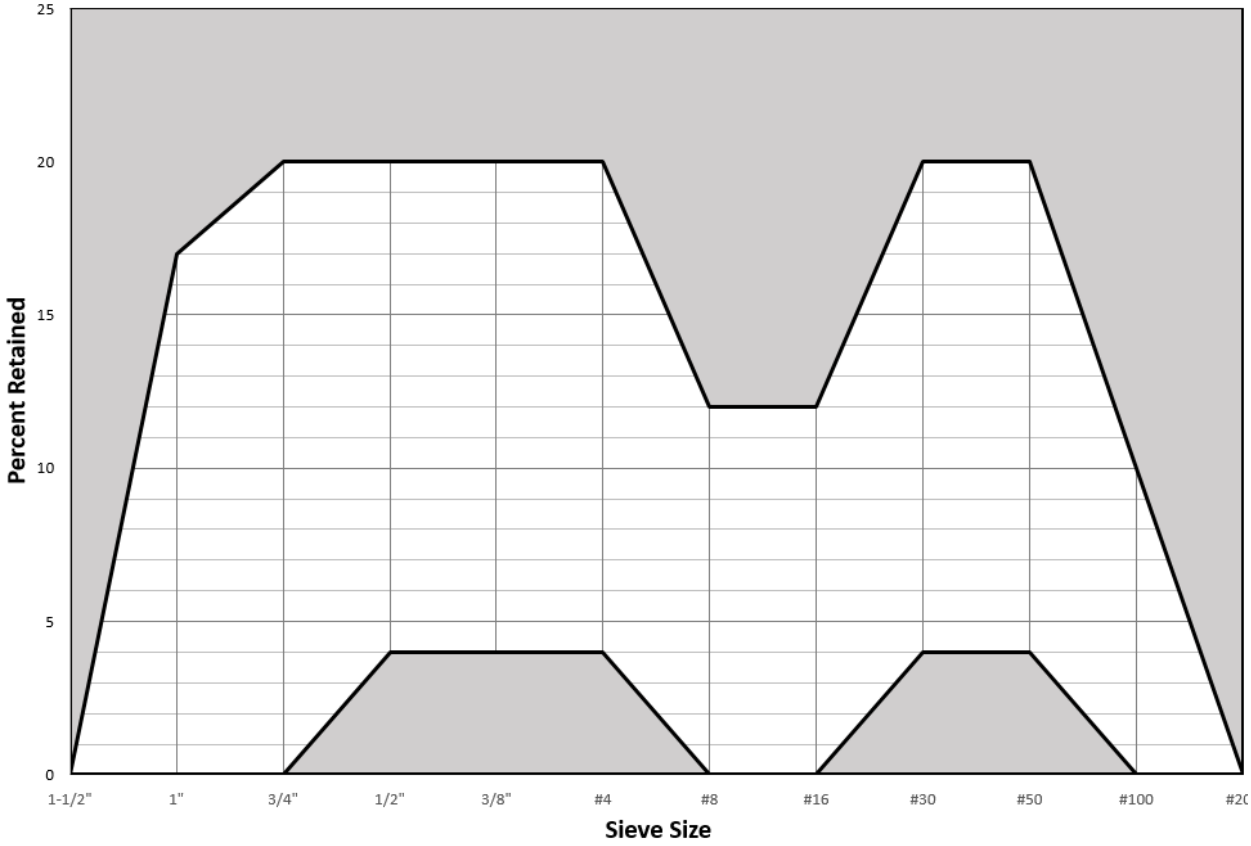


Fig. 8.9.2.2—Coarseness factor chart for evaluating potential performance of mixture.

ATTACHMENT C - COMBINED AGGREGATE GRADATION CHART

COMBINED AGGREGATE GRADATION CHART



ATTACHMENT D - CONCRETE PLACEMENT CHECKLIST

CONCRETE PLACEMENT CHECKLIST

Project: _____ Class of Concrete: _____

Project No: _____ Test Cylinders Taken? Yes: _____ No: _____

Preparation Slab	Contractor	N/A
Compaction Subgrade		
Filter Fabric/Drain Rock-ABC/Separator Fabric		
Drain Rock, Pea Gravel & Void Form		
Starter Wall Forms		
Reinforcing Steel		
Screeds		

Embedded Items	Contractor	N/A
A. Anchor Bolts		
B. Water Stop		
C. Rebar		
D. Electrical		
E. Plumbing Rough-in		
F. Mechanical		
G. HVAC		

Concrete Placement Equip.	Contractor	N/A
A. Crane		
B. Buckets		
C. Hoppers		
D. Vibrators		
E. Elephant trunks		
F. Floodlights		
G. Pump Truck		

Building Department Notification	
Date:	Time:

Prep Wall Concrete	Contractor	N/A
Access To Work		
Ladders Secured		
Clean up and Washed Out		
Reinforcing Steel		

Forms	Contractor	N/A
A. Alignment & Grade		
B. Scaffolding		
C. Sleeves & Wall Castings		
D. Embedded Items		
E. Electrical		
F. Plumbing Rough-in		
G. Piping		

Record of Curing Conditions During Placement	
Start:	Finish:
Date:	
Time:	
Weather:	
Temperature:	
Comments:	

Location of Placement _____

The Contractor certifies the above-proposed concrete placement is prepared as indicated and is in accord with the Contract Drawings and Specifications. The Contractor requests permission to begin placement of concrete on the date of _____ at _____. The estimated number of yards is _____. The estimated duration of the placement is _____.

By: _____
Contractor

Released for placement by: _____
Engineer

SECTION 03_35_29

CONCRETE FINISHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Concrete finishes.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117-10 - Specification for Tolerances for Concrete Construction and Materials and Commentary.

B. International Concrete Repair Institute (ICRI):
   1. Guideline No. 301.2: Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Grade line: A reference line that separates surfaces considered to be above grade from those considered to be below grade. Located 12 inches below finished grades at the perimeter of the structure.
   2. Water line: A reference line that separates surfaces considered to be above the water level (and visible in the finished work) from those considered to be below the water level (and not visible in the finished work). For each water-bearing cell of a structure, defined as a line located 2 feet below the normal operating water level in that cell.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Finishing personnel:
      a. Use qualified flatwork finishers.
      b. Finishing supervisor must have at least 5 years of experience finishing concrete.

B. Mockups:
   1. Construct mockup panels showing finishing of formed surfaces for review by the Engineer.
      a. Construct mockup panels demonstrating concrete finishes for vertical surfaces:
         1) Construct mockup panels for F4 and F5 finishes and tie-hole repairs for review by the Engineer.

2. Construct mockup slabs showing finishing of unformed surfaces for review by the Engineer.
    a. Construct mockup slabs demonstrating concrete finishes for horizontal surfaces:
        1) Construct mockup slabs for S1, S2, S4, and S5 finishes.
3. Include the following elements in mockup panels and slabs.
    a. Concrete joints:
        1) Horizontal and vertical joints of the types included in the Work.
    b. Concrete repairs:
        1) Repairs using materials and procedures proposed for the Work.
4. Construct mockup panels and slabs at the beginning of the Project for review by the Engineer.
5. Panels and portions thereof accepted by the Engineer will serve as the standard of quality and workmanship for the Work.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
    1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for mortar:
    1. As specified in Section 03_30_00 - Cast-in-Place Concrete, unless otherwise noted.
    2. Where finished surfaces will be visible in the finished work, use same cement used for concrete batches in that area. Add white cement if required to obtain color match between base concrete and finishing mortars.

2.02 MIXES

A. Cement mortar:
    1. As specified in Section 03_60_00 - Grouting.

B. Dry-pack mortar:
    1. As specified in Section 03_60_00 - Grouting.

C. Mortar mix for F4 finish (“F4 Mortar”):
    1. Consisting of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen. Mix with enough water and emulsified bonding agent to have consistency of thick cream.

D. Mortar mix for F5 finish (“F5 Mortar”):
    1. Consisting of 1 part cement to 1-1/2 parts of sand passing Number 16 screen.

2.03 EVAPORATION RETARDANT

A. As specified in Section 03_30_00 - Cast-in-Place Concrete.

2.04 NON-SLIP ABRASIVE

A. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate. Homogeneous, non-glazing, rust-proof, and unaffected by freezing, moisture, and cleaning compounds.

B. Manufacturers: One of the following or equal:
   1. Abrasive Materials Incorporated, Hillsdale, MI.
   2. Exolon Company, Tonawanda, NY.

2.05 CONCRETE SEALERS

A. Floor sealer and dust-proofer:
   1. Non-membrane forming, breathable, non-yellowing, penetrating sealer designed to densify and seal a cured concrete surface.
   2. Low odor, VOC content of 0 grams per liter, and stable when exposed to ultraviolet radiation from sunlight.
   3. Manufacturers: One of the following or equal:
      a. Dayton Superior, Day-Chem Sure Hard Densifier (J-17).
      b. Euclid Chemical Company, Euco Diamond Hard.
      c. L&M Construction Chemicals, Seal Hard.
      d. W.R. Meadows, Liqui-Hard.

PART 3 EXECUTION

3.01 CONCRETE FINISHING - FORMED SURFACES

A. Scope:
   1. Finish formed surfaces with one of the finishes specified in the following paragraphs and as indicated in the Schedule of Concrete Finishes in this Section.
   2. Formed surfaces are those surfaces that the plastic concrete is placed against a temporary containment surface that will be removed after the concrete sets and takes its final form.

B. General:
   1. Provide setting and curing time from casting of concrete to removal of forms as specified in Section 03_30_00 - Cast-in-Place Concrete.
   2. Provide curing after removal of forms as specified in Section 03_30_00 - Cast-in-Place Concrete.
   3. Materials and mixes for finishes.
      a. Cement: Add white cement to mortars and grouts used for finishing if required to match color of repairs to surrounding surfaces.
   4. Grinding:
      a. Where grinding of concrete surfaces is permitted:
         1) Perform grinding using an iron-free wheel, such as an aluminum oxide wheel, to avoid entrapment of particles that produce rust stains.
         2) At locations where plastic-protected reinforcing bar supports are used, limit grinding to a maximum depth of 1/16 inch.

C. F1 finish: “Rough Form Finish”:
   1. Repair defective work.
   2. Remove fins and other projections larger than 1/2 inch.
   3. Fill tie holes using dry-pack mortar.
   4. After removal of any curing compounds, fill depressions larger than 1 inch wide or 1/2 inch deep using dry-pack mortar.
   5. Leave surface with texture imparted by forms.
   6. Surface irregularity: Not exceeding a 1-inch gap when measured over the length of a 5-foot straightedge.

D. F2 finish: “Form Finish”:
   1. Repair defective work.
   2. Remove fins and other projections larger than 1/4 inch.
   3. Fill tie holes using dry-pack mortar.
   4. Fill depressions.
      a. Fill after removal of any curing compounds.
      b. Fill depressions larger than 1/2 inch in width or 1/2 inch in depth using cement mortar.
      c. Fill larger voids and depressions, use dry-pack mortar.
   5. Leave surfaces with texture imparted by forms.
   6. Surface irregularity: Not exceeding a 1/4-inch gap when measured over the length of a 5-foot straightedge.

E. F3 finish: “Smooth Form Finish”:
   1. Repair defective work.
   2. Repair rough or irregular surface finishes resulting from failure of form release agent or other form conditions and provide a smooth, uniform surface appearance.
   3. Remove fins: Grind offsets, projections, and rough spots larger than 1/8 inch smooth.
   4. Fill tie holes using dry pack mortar.
   5. Fill depressions:
      a. Fill after removal of any curing compounds.
      b. Fill depressions 1/4 inch and larger in depth or 3/4 inch in width using cement mortar.
      c. For larger depressions, fill using dry pack mortar.
   6. Top coat tie holes and filled depressions with cement mortar to provide uniform appearance.
   7. Leave surfaces with texture that is generally smooth and uniform in appearance.
   8. Surface irregularity: Not exceeding a 1/8-inch gap when measured over the length of a 5-foot straightedge.

F. F4 finish: “Rubbed Finish”:
   1. As specified for F3 finish, except prepare surfaces and fill depressions 1/16 inch or larger in depth or width as follows.
   2. Fill depressions.
      a. “Brush-off” sandblast surfaces to expose depressions and voids near the surface of the concrete.
      b. Thoroughly wet surfaces and begin filling depressions while surfaces are still damp.

c. Use clean burlap, sponge rubber floats, or trowels to rub plastic F4 mortar over the entire surface to be finished. Fill pits, holes, and depressions.
d. Wipe surfaces clean. Do not leave any mortar on the surface, except that within the depressions.
e. Cure: Moist cure surfaces.

G. F5 finish: “Stoned Finish”:
1. As specified for F3 finish, except add stoned finish as follows:
2. Fill depressions:
a. Wet surfaces thoroughly with brush.
b. Rub wetted surfaces with a hard wood float dipped in water containing 2 pounds of Portland cement per gallon of water.
c. Rub surfaces until form marks and projections are removed.
d. Using a brush, spread plastic grindings from the rubbing operation uniformly over the surface. Work the material in to fill pits and small voids.
e. Cure: Moist cure brushed surfaces for at least 72 hours.
3. Finish surfaces:
a. After curing, obtain final finish by rubbing with a No. 50 grit carborundum stone.
b. Continue rubbing until entire surface has a smooth texture and is uniform in color.
c. Cure: Continue curing for remainder of specified time.
4. If surfaces have become too hard to finish as specified in the preceding paragraphs, the following alternative procedure may be used:
a. Sandblast and wash related surfaces exposed to view, whether finished or not.
b. While surfaces are still damp, rub surface with mortar mix for F5 finish.
c. Finish by rubbing mortared surface with No. 60 grit carborundum stone. Add F5 mortar until surface is evenly filled without excess mortar. Continue stoning until surface is hard.
d. Moist cure surface for 72 hours.
e. After curing, make surface smooth in texture and uniform in color by rubbing with a No. 50 or No. 60 grit carborundum stone.
f. Continue curing until 7-day curing period is complete.

3.02 CONCRETE FINISHING - UNFORMED SURFACES

A. Scope:
1. Finish unformed surfaces with one of the finishes specified in the following paragraphs and as indicated in the Schedule of Concrete Finishes in this Section.
2. Unformed surfaces are those surfaces that are not cast against a temporary containment and the specified finish is achieved by tooling.

B. General:
1. Concrete placement:
a. Place concrete at a rate that allows spreading, straight-edging, and initial floating before bleed water appears.
1) Consider characteristics of concrete mixes used, including potential for accelerating or retarding effects of admixtures, fly ash, and temperatures, on plans for and scheduling of placement and finishing.

b. Place, consolidate, strike-off, and screed concrete level to bring surfaces to required planes and lines. Eliminate high and low spots.
c. Strike tops of walls and similar surfaces smooth and finish as specified to a texture consistent with that of adjacent formed surfaces.
d. After screeding, apply evaporation retardant to concrete surface if weather conditions will result in rapid evaporation of moisture from the surface of the concrete. Do not work evaporation retardant into the surface of the concrete.

2. Floating and re-straightening:
   a. Float concrete to compact and consolidate the surface.
   b. Initial floating:
      1) Provide initial floating immediately after screeding.
      2) Perform by hand using a wide bull float, darby, or highway straightedge.
      3) Complete before excess moisture or bleed water is present on the surface.
   c. Wait for concrete to stiffen and for the bleed water to stop rising and dissipate before proceeding with edging, hand-tooled jointing, and second floating.
   d. After initial floating, apply evaporation retardant to concrete surface if weather conditions will result in rapid evaporation of moisture from the surface of the concrete. Do not work evaporation retardant into the surface of the concrete.
   e. Second floating:
      1) Do not commence until bleed water has dissipated and concrete has stiffened enough to support weight of finishers and finishing equipment.
      2) May be by hand, or, if accepted by the Engineer, may be done using a bladed power float equipped with float shoes, or a power disk float.
      3) Float surfaces to a true, even plane, with no coarse aggregate visible.
      4) Evaporation retardant may not be applied after second floating.
   f. Flatness:
      1) Specified tolerances for flatness may require re-straightening of the surface between first and second floating operations and before steel troweling. Re-straighten concrete as required.
      2) Modify power equipment with alternate float shoes or other equipment if required to achieve specified flatness.

3. Troweling: Where finishes require troweling, conform to the following requirements:
   a. After surface moisture from floating has disappeared, steel trowel to a smooth, hard, dense concrete surface.
   b. Provide at least 2 trowelings.
      1) Avoid excessive troweling.
      2) Use smaller trowels for successive troweling.
      3) Make each successive troweling perpendicular to the previous pass.
   c. Do not add dry cement or additional water to the surface during troweling.
   d. In lieu of hand steel troweling, a power machine for finishing concrete may be used if accepted by the Engineer.
      1) Do not use power machine if concrete has not attained the set necessary to permit finishing without introduction of high and low spots into the concrete surface.

2) Use equipment in full compliance with the manufacturer's recommendations.
3) Use smaller blades or higher pressure for each successive troweling.
4) Hand trowel areas of the concrete not accessible to power equipment.
5) Tolerances for flatness specified may require re-straightening of the surface during finishing. Modify power equipment with alternate shoes or other equipment if required to achieve these requirements.

e. Finishing with a fresno trowel or finishing to a "fresno finish" is not allowed.

4. Finishing tolerances:
   a. Slabs sloped to drain: Finish surfaces to adequately drain toward designated points or lines, regardless of tolerances specified.

C. S1 finish: "Scratch Finish":
1. Place, consolidate, and screed concrete level.
2. Provide initial floating of concrete.
3. Provide surface conforming to the "Conventional" floor flatness tolerance requirements of ACI 117 using the manual straightedge method (maximum 1/2-inch gap in 10 feet at 90 percent of locations; maximum 3/4-inch gap at any location), unless otherwise indicated.
4. Before final set, roughen the surface with rakes.
   a. For sloped surfaces, rake grooves in the direction of drainage.
   b. Provide roughness equivalent to CSP 6 surface as designated by ICRI Guideline 310.2.
5. Pressure wash surface to remove laitance before placing grout or toppings.

D. S2 finish: "Floated Finish":
1. Place, consolidate, and screed concrete to required elevations and slopes.
2. Provide initial and second floatings of concrete. Float to a uniform texture.
3. Provide surface conforming to the "Flat" floor flatness tolerance requirements of ACI 117 using the manual straightedge method (maximum 1/4-inch gap in 10 feet at 90 percent of locations; maximum 3/8-inch gap at any location), unless otherwise indicated.
4. Remove laitance and leave surface clean.

E. S3 finish: "Steel Trowel Finish":
1. Place, consolidate, and screed concrete to required elevations and slopes.
2. Provide S2 Floated Finish.
3. Provide 2 trowelings:
4. Provide finish conforming to the "Flat" floor flatness tolerance requirements of ACI 117 (maximum 1/4-inch gap in 10 feet), unless otherwise indicated.

F. S4 finish: "Steel Trowel Finish - Free of Trowel Marks":
1. Finish as specified for S3 Steel Trowel Finish, except that final troweling shall remove all trowel marks from the slab surface.

G. S5 finish: "Broomed Finish":
1. Finish as specified for S2 Floated Finish, except modify as follows:
2. Finish surface by drawing a fine-hair broom lightly across the freshly floated surface.
   a. Provide resulting roughness for a non-skid surface. Finishing and roughness is subject to review and acceptance by the Engineer.

b. Direction of brooming:
    1) General:
        a) In same direction of and parallel to expansion joints.
        b) Perpendicular to primary direction of traffic.
    2) For sloped slabs, parallel to the direction of drainage.
    3) For round roof slabs, in the radial direction.

H. S6 finish: “Non-Slip Abrasive Finish”:
1. Place, consolidate, and screed concrete to required elevations and slopes.
2. Provide initial floating of surface.
3. Prepare and apply abrasive as recommended by the manufacturer.
    a. Apply using a shake screen or other accepted method to ensure even coverage without segregation of the abrasive.
    b. Install abrasive at a rate of 25 pounds for each 100 square feet of surface area.
4. After concrete has hardened enough to support the weight of a person and unless otherwise indicated by the abrasive manufacturer, apply approximately 2/3 of the abrasive material required for coverage.
5. Finish as specified for S2 Floated Finish, except that re-floating is not required.
6. Apply remaining abrasive material at right angles to the first application and in locations necessary to provide the minimum specified thickness.
7. Immediately after the second application, re-float the surface to embed abrasive.
8. Finish as specified for S2 Steel Trowel Finish. Trowel abrasive into the surface, properly exposing material to produce a non-slip finish.

I. Concrete sealer:
1. See Room Finish Schedule Drawings for locations of floors and slabs receiving concrete sealer finish.
2. Apply sealer in accordance with the manufacturer’s instructions.

3.03 FIELD QUALITY CONTROL

A. Provide field quality control for the Work of this Section as specified in Section 01_45_00 - Quality Control.

B. Field quality control by the Contractor:
1. Field inspections and testing:
    a. Submit records of inspections and testing to the Engineer within 24 hours after completion.
2. Manufacturer’s services.
    a. Non-slip abrasive finish. Before beginning installation, conduct pre-installation meeting with the manufacturer’s technical representative to review product use and installation requirements.

C. Field quality control by the Owner:
1. Special inspections, special tests, and structural observation:
    a. Not required.
2. Field inspections:
    a. Observe construction for conformance to the Contract Documents and the accepted Submittals.
    b. Provide record of each inspection. Submit copies to the Engineer upon request.

3.04 NON-CONFORMING WORK

A. Unsatisfactory finishes that have hardened will require removal, grinding, topping, or other correction acceptable to the Engineer.

B. Re-work or refinish unsatisfactory finishes at no additional cost to the Owner.

C. Requirements as specified in Section 03_30_00 - Cast-In-Place Concrete.

3.05 SCHEDULE OF CONCRETE FINISHES

A. Formed surfaces: As specified in Table 03_35_29-A.

B. Unformed surfaces: As specified in Table 03_35_29-B.

Table 03_35_29-A: Concrete Finishes - Formed Surfaces				
Elements	**Location**	**Surface Exposure**	**Finish**	**Notes**
Exterior Surfaces:				
Walls, columns, slab edges	Wet structure	Above grade or water line		
		Exposed to view	F4	
		Covered	F2	1a
		Below grade or water line		
		No coating	F1	
		Bituminous coating	F2	
		Waterproofing	F3	
	Dry structure	Above grade line		
		Exposed to view	F4	
		Covered	F2	1a
		Below grade line		
		No coating	F1	
		Bituminous coating	F2	
		Waterproofing	F3	
Interior Surfaces:				
Walls, columns, slab edges	Wet structure	Open basin		
		Above water line	F4	
		Below water line	F3	
		Covered basin		
		Above water line	F3	
		Below water line	F3	
	Dry structure	Exposed to view	F4	
		Covered	F2	1b
Overhead slabs and beams	Wet structure	Open basin	F3	1c, 1d
		Covered basin	F2	1d
	Dry structure	Exposed	F3	1c, 1d
		Covered by ceiling	F1	1d

Notes:
(1a) Coverings include additional surfaces applied over the concrete, such as veneer, stucco, plaster, etc.
(1b) Coverings include additional surfaces applied over the concrete, such as veneer, stucco, plaster, furring strips with drywall, etc.
(1c) Applies to overhead surfaces visible from normal pedestrian travel routes.
(1d) At overhead slabs and beams, patch tie holes on sides of members.

Table 03_35_29-B: Concrete Finishes - Unformed Surfaces				
Element	**Location**	**Exposure**	**Finish**	**Notes**
Exterior Surfaces:				
Footings	Extensions	Exposed	S3	
		Covered by soil	S2	
Slabs and beams - exposed	Walking or possible walking paths	Tops of treatment structures	S5	2a, 2b, 2g, 2h
		Stairs and landings	S5	
	Roofs	Exposed	S5	
		Covered by roofing	S2	
Slabs and beams - submerged	Unless otherwise noted	All	S3 (S5 if concrete is air entrained)	2g
Walls, corbels	Top of wall or corbel	All	S3	One troweling
Sidewalks	All		S5	
Equipment slabs	All		S5	
Interior Surfaces:				
Floor slabs, includes flat and sloping surfaces	Wet structure	Exposed		
		Basins and channels	S3	
		Covered		
		To receive basin bottom grout	N/A	N/A
		To receive concrete fill	S1	2f
	Dry structure	Exposed		
		Pipe galleries	S4	2c
		Stairs and landings	S4	2d
		Shops and garages	S4	
		Equipment rooms	S4	
		Covered		
		Tile on mortar bed	S2	
		Resilient flooring	S3	
		Carpet	S3	

Notes:

(2a) Includes slabs covering tanks, basins, channels and similar structures.
(2b) Includes tops of walls or beams that serve as walkways.
(2c) In galleries with slabs subject to wetting, provide broom finish (S5) where indicated on the Drawings.
(2d) Provide broom finish (S5) where indicated on the Drawings.
(2e) Finish for basin bottom grout: Not applicable (N/A).
(2f) Finish for concrete fill: See floor slab, wet structure, exposed basins and channels.
(2g) Slabs include flat and sloping surfaces.
(2h) Includes top of vault slabs exposed to traffic.

END OF SECTION

SECTION 03_60_00

GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cement grout.
   2. Cement mortar.
   3. Dry-pack mortar.
   4. Epoxy grout.
   5. Grout.
   6. Non-shrink epoxy grout.
   7. Non-shrink grout.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch cube specimens).
   2. C230 - Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   3. C531 - Standard Test Method for Liner Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   4. C579 - Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.
   5. C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   6. C942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   7. C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   8. C1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.

B. International Concrete Repair Institute (ICRI):
   1. 310.2R - Selecting and specifying Concrete Surface Preparations for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

A. Cement grout:
   1. Mix design.
   2. Material Submittals.

B. Cement mortar:
   1. Mix design.
   2. Material Submittals.

C. Non-shrink epoxy grout:
   1. Manufacturer's literature.

D. Non-shrink grout:
   1. Manufacturer's literature.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to jobsite in their original, unopened packages or containers, clearly labeled with manufacturer's product identification and printed instructions.

B. Store materials in cool dry place and in accordance with manufacturer's recommendations.

C. Handle materials in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Non-shrink epoxy grout:
   1. Manufacturers: One of the following, or equal:
      a. Five Star Products, Inc., Five Star DP Epoxy Grout.
      b. L&M Construction Chemicals, Inc., EPOGROUT.
      c. Master Builder Solutions/Sika, MasterFlow 648.
   2. Non-shrink epoxy grout shall be 100 percent solid, premeasured, prepackaged system containing 2-component thermosetting epoxy resin and inert aggregate.
   3. Maintain flowable consistency for at least 45 minutes at 70 degrees Fahrenheit.
   4. Shrinkage or expansion: Less than 0.0006 inches per inch when tested in accordance with ASTM C531.
   5. Minimum compressive strength: 10,000 pounds per square inch at 24 hours and 14,000 pounds per square inch at 7 days when tested in accordance with ASTM C579, Method B.
   6. Compressive creep: Not exceed 0.0037 inches/per inch when tested under 400 pounds per square inch constant load at 140 degrees Fahrenheit in accordance with ASTM C1181.
   7. Coefficient of thermal expansion: Not exceed 0.000018 inches per inch per degree Fahrenheit when tested in accordance with ASTM C531, Method B.

B. Non-shrink grout:
   1. Manufacturers: One of the following, or equal:
      a. Five Star Products, Inc., Five Star Grout.
      b. L&M Construction Chemicals, Inc., CRYSTEX.
      c. Master Builder Solutions/Sika, MasterFlow 928.
   2. In accordance with ASTM C1107.
   3. Preportioned and prepackaged cement-based mixture.

4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
5. Require only addition of potable water.
6. Water for pre-soaking, mixing, and curing: Potable water.
7. Free from emergence of mixing water from within or presence of water on its surface.
8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C230.
    a. If at fluid consistency, verify consistency in accordance with ASTM C939.
9. Dimensional stability (height change):
    a. In accordance with ASTM C1107, volume-adjusting Grade B or C at 45 degrees Fahrenheit to 90 degrees Fahrenheit.
    b. Have 90 percent or greater bearing area under bases.
10. Have minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C1107 for various periods from time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C109 as modified by ASTM C1107.

2.02 MIXES

A. Cement grout:
    1. Use same sand-to-cementitious materials ratio for cement grout mix that is used for concrete mix.
    2. Use same materials for cement grout that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete.
    4. For spreading over surfaces of construction or cold joints.

B. Cement mortar:
    1. Use same sand-to-cementitious materials ratio for cement mortar mix that is used for concrete mix.
    2. Use same materials for cement mortar that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.
    4. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.

C. Dry-pack mortar:
    1. Proportions by weight: 1 part Portland cement to 2 parts concrete sand.
        a. Portland cement: As specified in Section 03_30_00 - Cast-in-Place Concrete.
        b. Concrete sand: As specified in Section 03_30_00 - Cast-in-Place Concrete.

D. Epoxy grout:
    1. Consist of mixture of epoxy or epoxy gel and sand.
        a. Epoxy: As specified in Section 03_63_01 - Epoxies.
        b. Epoxy gel: As specified in Section 03_63_01 - Epoxies.
        c. Sand: Clean, bagged, graded, and kiln-dried silica sand.

2. Proportioning:
    a. For horizontal work: Consist of mixture of 1 part epoxy with not more than 2 parts sand.
    b. For vertical or overhead work: Consist of 1 part epoxy gel with not more than 2 parts sand.

E. Grout:
1. Mix in proportions by weight: 1 part Portland cement to 4 parts concrete sand.
    a. Portland cement: As specified in Section 03_30_00 - Cast-in-Place Concrete.
    b. Concrete sand: As specified in Section 03_30_00 - Cast-in-Place Concrete.

F. Non-shrink epoxy grout:
1. Mix in accordance with manufacturer's installation instructions.

G. Non-shrink grout:
1. Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and loose material or foreign matter likely to reduce bond or performance of grout or mortar.

3.02 PREPARATION

A. Surface preparation for grouting other baseplates:
1. Remove grease, oil, dirt, dust, curing compounds, laitance, and other deleterious materials that may affect bond to concrete and bottoms of baseplates.
2. Roughen concrete surfaces in contact with grout to ICRI CSP-6 surface profile or rougher.
    a. Remove loose or broken concrete.
3. Metal surfaces in contact with grout: Grit blast to white metal surface.

3.03 INSTALLATION

A. Mixing:
1. Cement grout:
    a. Use mortar mixer with moving paddles.
    b. Pre-wet mixer and empty out excess water before beginning mixing.
2. Cement mortar:
    a. Use mortar mixer with moving paddles.
    b. Pre-wet mixer and empty out excess water before beginning mixing.

3. Dry-patch mortar:
    a. Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.
4. Non-shrink epoxy grout:
    a. Keep temperature of non-shrink epoxy grout from exceeding manufacturer's recommendations.
5. Non-shrink grout:
    a. May be drypacked, flowed, or pumped into place. Do not overwork grout.
    b. Do not retemper by adding more water after grout stiffens.

B. Placement:
1. Cement grout:
    a. Exercise care in placing cement grout because it is required to furnish structural strength, impermeable water seal, or both.
    b. Do not use cement grout that has not been placed within 30 minutes after mixing.
2. Cement mortar:
    a. Use mortar mixer with moving paddles.
    b. Pre-wet mixer and empty out excess water before beginning mixing.
3. Epoxy grouts:
    a. Wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grout.
4. Non-shrink epoxy grout:
    a. Mix in complete units. Do not vary ratio of components or add solvent to change consistency of mix.
    b. Pour hardener into resin and mix for at least 1 minute and until mixture is uniform in color. Pour epoxy into mortar mixer wheelbarrow and add aggregate. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in mix.
5. Non-shrink grout:
    a. Add non-shrink cement grout to premeasured amount of water that does not exceed the manufacturer's maximum recommended water content.
    b. Mix in accordance with manufacturer's instructions to uniform consistency.

C. Curing:
1. Cement based grouts and mortars:
    a. Keep continuously wet for minimum of 7 days. Use wet burlap, soaker hose, sun shading, ponding, and in extreme conditions, combination of methods.
    b. Maintain above 40 degrees Fahrenheit until it has attained compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for minimum of 24 hours to avoid damage from subsequent freezing.
2. Epoxy based grouts:
    a. Cure grouts in accordance with manufacturers' recommendations.
        1) Do not water cure epoxy grouts.
    b. Do not allow any surface in contact with epoxy grout to fall below 50 degrees Fahrenheit for minimum of 48 hours after placement.

D. Grouting equipment bases, baseplates, soleplates, and skids: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

E. Grouting other baseplates:
   1. General:
      a. Use non-shrink grout as specified in this Section.
      b. Baseplate grouting shall take place from 1 side of baseplate to other in continuous flow of grout to avoid trapping air in grout.
      c. Maintain hydrostatic head pressure by keeping level of grout in headbox above bottom of baseplate. Fill headbox to maximum level and work grout down.
      d. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate grout, and remove trapped air.
   2. Forms and headboxes:
      a. Build forms using material with adequate strength to withstand placement of grouts.
      b. Use forms that are rigid and liquidtight. Caulk cracks and joints with elastomeric sealant.
      c. Line forms with polyethylene for easy grout release. Coating forms with 2 coats of heavy-duty paste wax is also acceptable.
      d. Headbox shall be 4 to 6 inches higher than baseplate and shall be located on 1 side of baseplate.
      e. After grout sets, remove forms and trim back grout at 45 degree angle from bottom edges of baseplate.

3.04 FIELD QUALITY CONTROL

A. Non-shrink epoxy grout:
   1. Test for 24-hour compressive strength in accordance with ASTM C579, Method B.

B. Non-shrink grout:
   1. Test for 24-hour compressive strength in accordance with ASTM C942.

END OF SECTION

SECTION 03_63_01

EPOXIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Epoxy.
   2. Epoxy gel.
   3. Epoxy bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Systems for Concrete.
   2. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: Submit manufacturer's data completely describing epoxy materials:
   1. Submit evidence of conformance to ASTM C881. Include manufacturer's designations of Type, Grade, Class, and Color.
   2. Submit documentation that materials meet or exceed the specified strength and performance characteristics. Indicate test methods and test results.

C. Quality control Submittals:
   1. Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
   1. Provide epoxy materials that are new.
   2. Store and use products within limitations in accordance with the manufacturer.
   3. Perform and conduct Work of this Section in a neat, orderly manner.

2.02 MATERIALS

A. General:
   1. Moisture tolerant, water-insensitive, two-component epoxy resin adhesive material containing 100 percent solids, and meeting or exceeding the performance properties specified when tested in accordance with the standards specified.

B. Epoxy: Low viscosity product in accordance with ASTM C881; Types I, II, and IV; Grade 1; Class C, except as modified in this Section.
   1. Manufacturers: One of the following, or equal:
      a. Dayton Superior, Unitex Pro-Poxy 100.
      b. Master Builders Solutions/Sika, MasterInject 1380.
      c. Sika Corporation, Sikadur 35 Hi-Mod LV.
   2. Required properties:

Table 1. Material Properties - Epoxy

Property	Test Method	Required Results ("neat")
Tensile Strength (7-day)	ASTM D638	7,000 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	10,000 pounds per square inch, minimum.
Bond Strength (harded concrete to harded concrete after 2-day cure)	ASTM C882	1,000 pounds per square inch, minimum. Concrete failure before failure of epoxy.
Viscosity (mixed)		250 to 550 centipoise

Notes:

(1) Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.

C. Epoxy gel: Non-sagging product in accordance with ASTM C881, Types I and IV, Grade 3, Class C.
   1. Manufacturers: One of the following, or equal:
      a. Dayton Superior, Sure Anchor J50.
      b. Master Builders Solutions/Sika, MasterEmaco ADH 327.
      c. Sika Corp., Sikadur 31, Hi-Mod Gel.
   2. Required properties:

Table 2. Material Properties - Epoxy Gel

Property	Test Method	Required Results ("neat")
Tensile Strength (7-day)	ASTM D638	2,000 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,000 pounds per square inch, minimum.
Bond Strength (14-day)	ASTM C882	1,500 pounds per square inch, minimum.

Notes:

(1) Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.

D. Epoxy bonding agent: Non-sagging product in accordance with ASTM C881, Type II, Grade 2, Class C.
   1. Manufacturers: One of the following, or equal:
      a. Dayton Superior, Sure Bond J58.
      b. Master Builders Solutions/Sika, MasterEmaco ADH 326.
      c. Sika Chemical Corp., Sikadur 32 Hi-Mod LPL.
   2. Required properties:

Table 3. Material Properties - Epoxy Bonding Agent

Property	Test Method	Required Results
Tensile Strength (7-day)	ASTM D638	3,300 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,300 pounds per square inch, minimum.
Bond Strength (14-days)	ASTM C882	1,800 pounds per square inch, minimum. Concrete failure before failure of epoxy bonding agent.
Pot Life	-	Minimum 60 minutes at 77 degrees Fahrenheit.

Notes:
(1) Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.

   3. If increased contact time is required for concrete placement, epoxy resin/Portland cement bonding agent, as specified in Section 03_63_02 - Epoxy Resin/Portland Cement Bonding Agent, may be used instead of epoxy bonding agent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and cure epoxy materials in accordance with the manufacturer's installation instructions.

B. Epoxy:
   1. Apply in accordance with the manufacturer's installation instructions.

C. Epoxy gel:
   1. Apply in accordance with the manufacturer's installation instructions.
   2. Use for vertical or overhead work, or where high viscosity epoxy is required.
   3. Epoxy gel used for vertical or overhead work may be used for horizontal work.

D. Epoxy bonding agent:
   1. Apply in accordance with the manufacturer's installation instructions.
   2. Will not be required for filling form tie holes or for normal finishing and patching of similar sized small defects.

END OF SECTION

SECTION 03_63_02

EPOXY RESIN/PORTLAND CEMENT BONDING AGENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy resin/portland cement bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens).
   2. C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   3. C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   4. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

B. Federal Highway Administration (FHWA):
   1. FHWA-RD-86-193 - Highway Concrete Pavement Technology Development and Testing Volume V: Field Evaluation of SHRP C9206 Test Sites (Bridge Deck Overlays).

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sika Corp., Sika Armatec 110.

B. Substitutions: The use of other than the specified product will be considered, providing the Contractor requests its use in writing to the Engineer. This request shall be accompanied by:
   1. A certificate of compliance from an approved independent testing laboratory that the proposed substitute product meets or exceeds specified performance criteria, tested in accordance with the specified test standards.
   2. Documented proof that the proposed substitute product has a 1-year proven record of performance of bonding portland cement mortar/concrete to hardened portland cement mortar/concrete, confirmed by actual field tests and 5 successful installations that the Engineer can investigate.

2.02 MATERIALS

A. Epoxy resin/portland cement adhesive:
   1. Component "A" shall be an epoxy resin/water emulsion containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.

2. Component "B" shall be primarily a water solution of a polyamine.
3. Component "C" shall be a blend of selected portland cements and sands.
4. The material shall not contain asbestos.

2.03 DESIGN AND PERFORMANCE CRITERIA

A. Properties of the mixed epoxy resin/portland cement adhesive:
   1. Pot life: 75 to 105 minutes.
   2. Contact time: 24 hours.
   3. Color: Dark gray.

B. Properties of the cured epoxy resin/portland cement adhesive:
   1. Compressive strength in accordance with ASTM C109:
      a. 3 day: 4,500 pounds per square-inch minimum.
      b. 7 days: 6,500 pounds per square-inch minimum.
      c. 28 days: 8,500 pounds per square-inch minimum.
   2. Splitting tensile strength in accordance with ASTM C496:
      a. 28 days: 600 pounds per square-inch minimum.
   3. Flexural strength:
      a. 1,100 pounds per square-inch minimum in accordance with ASTM C348.
   4. Bond strength in accordance with ASTM C882 modified at 14 days:
      a. 0 hours open time: 2,800 pounds per square-inch minimum.
      b. 24 hours open time: 2,600 pounds per square-inch minimum.
   5. The epoxy resin/portland cement adhesive shall not produce a vapor barrier.
   6. Material must be proven to prevent corrosion of reinforcing steel when tested under the procedures as set forth by the FHWA Program Report Number FHWA-RD-86-193. Proof shall be in the form of an independent testing laboratory corrosion report showing prevention of corrosion of the reinforcing steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mixing the epoxy resin: Shake contents of Component "A" and Component "B." Empty all of both components into a clean, dry mixing pail. Mix thoroughly for 30 seconds with a jiffy paddle on a low-speed with 400 to 600 revolutions per minute drill. Slowly add the entire contents of Component "C" while continuing to mix for a minimum of 3 minutes and until uniform with no lumps. Mix only the quantity that can be applied within its pot life.

B. Placement procedure:
   1. Apply to prepared surface with stiff-bristle brush, broom, or "hopper-type" spray equipment:
      a. For hand applications: Place fresh plastic concrete/mortar while the bonding bridge adhesive is wet or dry, up to 24 hours.
      b. For machine applications: Allow the bonding bridge adhesive to dry for 12 hours minimum.

C. Adhere to all limitations and cautions for the epoxy resin/portland cement adhesive in the manufacturer's current printed literature.

3.02 CLEANING

A. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

END OF SECTION

SECTION 03_64_25

HYDROPHILIC AND HYDROPHOBIC FOAM POLYURETHANE RESIN INJECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Hydrophilic foam polyurethane resin injection system.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D3574 - Standard Test Methods for Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: Submit manufacturer's data completely describing polyurethane resin injection system materials.

C. Quality control Submittals:
   1. Certificates of Compliance.
   2. Manufacturer's instructions.
   3. Protection plan for surrounding areas and non-cementitious surfaces.

1.04 QUALITY ASSURANCE

A. Products:
   1. Provide materials that are new and use them within shelf life limitations set forth by the manufacturer.

B. Qualifications:
   1. Installer:
      a. Minimum 5 years' experience in concrete repair with focus on application of similar systems and products to projects of similar size and scope.

C. Pre-installation meeting:
   1. At least 1 week prior to commencing work of this Section, convene a meeting at the project site to review and discuss the following:
      a. Surface preparation.
      b. Substrate conditioning and pre-treatment.
      c. Installation procedures.
      d. Environmental conditions (including weather forecast) and curing requirements.

e. Testing and inspection procedures.
f. Protection of surrounding surfaces and equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Labels shall indicate product identification, batch numbers, and shelf life.

B. Store materials off the ground, away from moisture and direct sunlight, and at temperatures within manufacturer's recommended range.

C. Pre-condition materials to manufacturer's recommended temperatures before using.

1.06 PROJECT CONDITIONS

A. Take precautions to protect surfaces and equipment in the work area from damage and staining.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
1. Polyurethane resin injection systems that will be in direct contact with water after the Work is completed shall comply with applicable federal, state, or local regulations.
2. Repair materials shall be free of chlorides or alkalis (except for those attributed to water).
3. To ensure compatibility of materials and methods, a single manufacturer shall produce and provide all products used together in a single area of concrete repair.

B. Manufacturers: One of the following, or equal:
1. Master Builders Solutions/Sika, MasterInject 1210 IUG (formerly Concresive 1210 IUG).

C. Resin:
1. Water-insensitive 1-part low-viscosity polyurethane resin adhesive material containing 100-percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified:

Physical Characteristic	Required Results
Viscosity	400 to 600 CPS at 70 degrees Fahrenheit
Flash Point	Greater than 200 degrees Fahrenheit
Corrosiveness	Non-corrosive
Reaction Time	75 to 90 seconds at 80 degrees Fahrenheit
Toxicity	Non-toxic

a. Uncured.
b. Cured foam (1:1):

Physical Characteristic	Test Method	Required Results
Tensile Strength	ASTM D3574	150 to 400 pounds per square inch
Elongation	ASTM D3574	400 to 1,200 percent

2.02 EQUIPMENT

A. Pump unit:
   1. Furnish unit to be used for injection that is positive displacement type with interlock to provide in-line mixing and metering system for 1 component polyurethane resin.
   2. Furnish pressure hoses and injection nozzle of such design as to allow proper mixing of polyurethane resin.
   3. Standby injection unit may be required.

B. Resin pump: Operating pressure in excess of 2,000 pounds per square inch with a variable pressure control trigger mechanism with attached pressure gauge, on the downstream end of the material supply hose.

C. Water pump: High-pressure water blaster capable of 1,000 pounds per square inch or higher pressure.

D. Incidentals: To be determined by site conditions and Contractor. See Installation Bulletin 6I12 - Urethane Injection, from Master Builders Solutions Construction Chemicals, LLC.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Confirm that surface temperatures and moisture conditions are within manufacturer's recommended limits. Condition surfaces to within those limits before commencing urethane injection.
   2. Sweep or clean area in vicinity of cracks and joints that will be injected with polyurethane resin.
   3. Clean cracks and joints so they are free from dirt, laitance, and other loose matter.

3.02 INSTALLATION

A. Install and cure polyurethane resin materials in accordance with manufacturer's installation instructions.

B. Mixing:
   1. Mix urethane in accordance with manufacturer's installation instructions.

C. Injection:
    1. Apply adequate surface seal to crack or joint to prevent escape of polyurethane resin.
    2. Establish injection ports along seal at a spacing not greater than the thickness of cracked member.
    3. Inject polyurethane resin into crack or joint at first port with sufficient pressure to advance polyurethane resin to adjacent port. Start at lowest port along the injection line and work upwards.
        a. Seal original port and shift injection to next adjacent port at which polyurethane resin appears.
        b. Continue port-to-port injection until each crack or joint has been injected for its entire length.
    4. For small amounts of polyurethane, or where excessive pressures developed by injection pump unit might further damage the structure, material mixed and installed with a hand caulking gun may be used if acceptable to the Engineer.
    5. Seal ports, including adjacent locations where polyurethane resin seepage occurs, as necessary to prevent drips or run out.
    6. After injection is complete, remove surface seal material and re-finish concrete in the area where the polyurethane was injected to match surrounding concrete. Leave finished work and work area in a neat and clean condition.

3.03 FIELD QUALITY CONTROL

A. Provide Contractor quality control as specified in Section 01_45_00 - Quality Control.

B. Field inspections and tests:
    1. Submit records of inspections and test to Engineer within 24 hours after completion.

C. Manufacturer’s services.
    1. Pre-installation meeting: Provide manufacturer’s technical representative to attend pre-installation meeting specified in Section 01_45_00 - Quality Control.

3.04 FIELD QUALITY ASSURANCE

A. Provide Owner quality assurance as specified in Section 01_45_00 - Quality Control.

B. Special inspections, special tests, and structural observation:
    1. Not required.

C. Field inspections:
    1. Preparation.
        a. Review manufacturer’s product data and installation instructions.
    2. Required inspections:
        a. Observe surfaces to be injected for temperature and moisture conditions.
        b. Observe conditioning and preparation of urethane resin.
        c. Observe injection procedures for filling cracks.
    3. Records of inspections:
        a. Provide record of each inspection.
        b. Submit to Engineer upon request.

3.05 NON-CONFORMING WORK

A. Cracks, after injection, shall show no evidence of running or seeping water. Re-inject as necessary to provide watertight seal at no additional cost to Owner.

B. Rework surface finishes that do not match surrounding concrete to the satisfaction of the Engineer at no additional cost to Owner.

END OF SECTION

SECTION 03_70_30

THERMAL CONTROL OF CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Monitoring and control of concrete hydration temperatures during set and curing.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C150 - Standard Specification for Portland Cement.

1.03 SUBMITTALS

A. Product data.

B. Thermal Control Plan.
   1. The plan shall be stamped and signed by a professional engineer meeting the quality assurance requirements specified in this Section.

C. Temperature Monitoring Program.

D. Temperature monitoring data:
   1. Tabular data of hourly concrete temperature for each temperature sensor.
   2. Tabular data for hourly concrete temperature differential for each temperature sensor.
   3. Plot of temperature and temperature differential for each temperature sensor.

E. Layout of cooling pipe system, if used, showing pipe sizes and material type, connections, location, spacing, method of support, and system for monitoring temperature of water in cooling pipes.

1.04 QUALITY ASSURANCE

A. Engineer in responsible charge of development of the Thermal Control Plan shall be a professional civil or structural engineer holding a current license in the jurisdiction where the Work will be installed and have the following qualifications:
   1. Demonstrate at least 10 years recent experience in completion of thermal control plans.
   2. Demonstrate completion of thermal control plans of at least 20 successful projects. Provide contact references for at least 5 projects in the last 2 years.
   3. The Engineer has determined that the following engineers are qualified to develop thermal control plans:
      a. Beton Consulting Engineers.
      b. MJ2 Consulting, PLLC.

4. Contractor's request to use alternate engineers may be considered if qualifications and examples of work product are submitted to the Engineer for approval as follows:
    a. Cover letter listing proposed engineer's qualifications.
    b. Examples of thermal control plans for 5 previous projects, including project name, date, location, and name of contact with telephone number.
    c. The decision to permit the use of alternate engineers will be at the sole discretion of the Engineer, and the decision of the Engineer shall be final.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
    1. Thermal Control Plan:
        a. General:
            1) Thermal Control Plan to include the following as a minimum:
                a) Based on range of average daily ambient air temperatures and initial concrete temperature at point of placement, calculate following for each concrete placement.
                    (1) Maximum concrete temperature.
                    (2) Time from concrete placement until maximum concrete temperature occurs.
                    (3) Maximum concrete differential temperature.
                    (4) Time from concrete placement until maximum concrete differential temperature occurs.
                    (5) Length of thermal control period.
                b) Concrete mix design meeting the requirements of Section 03_30_00 - Cast-in-Place Concrete.
                c) Duration and method of curing.
                d) Procedures to control concrete temperature at time of placement.
                e) Methods of controlling maximum concrete differential temperature.
                    (1) Include minimum temperature of adjacent concrete at construction joints.
                f) Temperature sensor types and placement locations.
                g) Temperature monitoring and recording system.
                h) Field measures to ensure conformance with maximum concrete temperature and maximum concrete temperature differential requirements.
                i) Corrective measures to take if it appears specified concrete maximum temperature and maximum concrete differential temperature will be exceeded.
            2) Have temperature control measures in place during the placement of concrete to limit maximum initial concrete temperature rise to 20 degrees Fahrenheit.
            3) Difference in temperature between concrete interior and surface temperatures shall not exceed 35 degrees Fahrenheit.
            4) Allow interior of concrete to cool down and stabilize.

5) Maximum allowable concrete temperature: 145 degrees Fahrenheit.
6) Do not place concrete until Engineer has accepted in writing, Thermal Control Plan.

b. Pre-cooling of concrete:
1) Cool concrete mix prior to placement, by following means:
a) Cool batch water.
b) Ice may be substituted for portion of batch water.
c) Continuously spray coarse aggregate with water to cool aggregate. Adjust batch water content to account for added water content in aggregate due to use of cooling water.
d) Nitrogen injection.
e) Alternative means proposed by Contractor that are acceptable to Engineer.

c. Post-cooling of concrete:
1) At Contractor's option, use embedded thin walled piping for circulating water to control temperature gain in previously cast concrete.
2) Clearly indicate in Thermal Control Plan if cooling piping will be embedded in concrete.
3) Do not install embedded piping within top 20 inches of slab or wall.
4) Operate cooling pipe system for duration of cooling period. Cooling period shall be minimum of 14 days.
5) After use of cooling pipes to cool concrete is complete, fill pipes with grout.

2. Temperature monitoring program:
a. Temperature monitoring and recording system:
1) Consist of temperature sensors connected to data acquisition system capable of printing, storing, and downloading data to computer.
2) Locate temperature sensors so that maximum temperature difference within mass concrete element can be monitored.
3) As minimum, monitor concrete temperatures at calculated hottest location, on at least 2 outer faces, and top surface.
4) Print and submit temperature data to Engineer daily.

b. Temperature control period:
1) Maintain temperature control measures until following requirements are met:
a) Maximum internal concrete temperature has been reached and temperature is falling.
b) Difference between interior concrete temperature and the average daily air temperature is less than allowable temperature difference for 3 consecutive days.
c) 5 days have elapsed since concrete was placed.
d) There are no adjacent mass concrete elements to be cast.
2) Monitor concrete temperatures during Temperature Control Period.
3) Do not place adjacent concrete placements during Temperature Control Period.

c. Concrete consolidation:
1) Use methods that prevent damage to temperature monitoring and recording system.

d. Temperature sensor and wiring:
    1) Protect wiring connected to temperature sensors cast into concrete to prevent movement.
    2) Keep wire runs as short as possible.
    3) Do not allow ends of temperature sensors to come into contact with supports concrete forms or reinforcing bars.
e. Equipment failure:
    1) When any equipment used in temperature control, monitoring, and recording system fails during concrete construction operation, take immediate measures to correct situation in accordance with Thermal Control Plan.
    2) Failure to conform to temperature requirements will be cause for rejection of concrete.

2.02 MATERIALS

A. Concrete admixtures:
    1. Air entraining admixture:
        a. As specified in Section 03_30_00 - Cast-in-Place Concrete.
    2. Retarding admixture:
        a. At Contractor's option, set retarding admixture may be used to control set time and minimize premature setting of concrete and formation of cold joints.
        b. As specified in Section 03_30_00 - Cast-in-Place Concrete.
    3. Water reducing admixture:
        a. As specified in Section 03_30_00 - Cast-in-Place Concrete.
    4. Accelerating admixtures:
        a. Do not use.

B. Aggregates:
    1. As specified in Section 03_30_00 - Cast-in-Place Concrete.

C. Portland cement:
    1. Type II low alkali: As specified in Section 03_30_00 - Cast-in-Place Concrete.
    2. Do not use Type III in accordance with ASTM C150.

D. Fly ash:
    1. As specified in Section 03_30_00 - Cast-in-Place Concrete.

E. Concrete insulating blankets:
    1. Commercially available concrete insulating blankets, with R-value required in Thermal Control Plan.

F. Water and ice:
    1. Mixing water: As specified in Section 03_30_00 - Cast-in-Place Concrete.
    2. Water for making ice: Meet requirements of mixing water as specified in Section 03_30_00 - Cast-in-Place Concrete.
    3. Ice may be substituted for mixing water on 1 to 1 ratio based on weight.

2.03 TEMPERATURE MONITORING SYSTEM

A. Manufacturers: The following or equal:
   1. FLIR Systems, Inc., Engius IntelliRock II System.
   2. The Transtec Group, Inc., Command Center.

B. Temperature logger:
   1. Consist of temperature sensor, microprocessor, and battery encased in polyester resin for protection.
   2. Calculate and store temperature readings of concrete.
   3. Maximum wire length in concrete: 50 feet.
   4. Capable of logging temperature hourly for 28 days.

C. Handheld reader:
   1. Use to communicate with and collect data from temperature loggers embedded in concrete.
   2. Use to instruct loggers to begin reading, download data from loggers, and upload logger data to computer.
   3. Logger data storage: 999 logger downloads.

D. Software:
   1. Use system software to transfer data from handheld reader to computer in secure, unalterable, electronic files.

2.04 MIXES

A. As specified in Section 03_30_00 - Cast-in-Place Concrete for Class M concrete.

PART 3 EXECUTION

3.01 INSTALLATION

A. Concrete placement:
   1. As specified in Section 03_30_00 - Cast-in-Place Concrete except as modified in this Section.
   2. Preheat previously placed adjacent concrete to temperature above freezing.
   3. Do not place non-mass concrete with mass concrete.
   4. Do not place non-mass concrete until after Thermal Control period for adjoining mass concrete is complete.

B. Curing concrete:
   1. Water cure or plastic membrane cure as specified in Section 03_30_00 - Cast-in-Place Concrete as soon as possible following placement of concrete.
      a. If water curing is used, use methods that minimize differential temperature between curing water and concrete.
      b. Consider type of curing in Thermal Control Plan.

C. Insulation:
   1. If insulation is required by Thermal Control Plan, install insulation on following during Thermal Control Period:
      a. Formed surfaces.
      b. Finished surface such as top of slabs.
      c. Temporary surfaces such as construction joints.
      d. Reinforcing bars protruding from concrete placements.
      e. Steel braces and catwalk supports attached to formwork.
      f. Pipes protruding from concrete placement.
      g. Conduits protruding from concrete placement.
      h. Minimum of 3 feet past concrete placement onto previously placed adjacent concrete.
      i. Other items protruding from concrete that would contribute to heat loss from concrete.
   2. Install insulation blankets on complete area of formwork that extends past concrete placement.
      a. Install insulation blankets tightly against formwork to prevent air movement between insulating blankets and forms.
      b. Install insulation on formwork before placing mass concrete.
   3. Install insulation on finished surfaces when:
      a. Finishing is complete.
      b. Concrete has sufficient strength to prevent damage due to installation of insulation.
      c. Before excessive temperature differential develops.
   4. Protruding reinforcing bars, conduits, and pipes:
      a. For 1-inch diameter, or minimum dimension, and smaller, insulate for minimum of 3 feet from face of concrete placement.
      b. For diameter, or minimum dimension, greater than 1 inch, insulate for minimum of 6 feet from face of concrete placement.
      c. Use insulation with R-Value equal to or greater than required for adjacent surface of concrete placement.
      d. Install insulation before placing mass concrete.
   5. Insulation shall remain in place until end of Thermal Control period.

D. Cold weather concreting:
   1. As specified in Section 03_30_00 - Cast-in-Place Concrete except do not use steam or other concrete heating methods that will increase concrete temperature outside range as specified in this Section.

E. Hot weather concreting:
   1. As specified in Section 03_30_00 - Cast-in-Place Concrete.
   2. Use fog sprayers to reduce ambient air temperature and increase humidity during concrete placement.

3.02 FIELD QUALITY CONTROL

A. Temperature Monitoring Program:
   1. Use temperature monitoring system to measure concrete temperatures in interior and near surface of concrete.
   2. Continuously monitor temperature of the interior of the concrete and surfaces of concrete during cooling period.

3. Temperature monitoring data not conforming to requirements of this Section:
    a. Stop placing concrete.
    b. Concrete not conforming to temperature requirements of this Section will be rejected. Remove rejected concrete at Contractor's expense.
    c. Modify Thermal Control Plan and calculations to correct problem and resubmit.
    d. Do not place concrete until revised Thermal Control Plan and calculations have been submitted and accepted by Engineer.

B. Concrete placement temperatures:
    1. Measure and record concrete temperature at point of placement.

END OF SECTION

SECTION 05_05_24

MECHANICAL ANCHORING AND FASTENING TO CONCRETE AND MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for:
   1. Cast-in anchors and fasteners.
   2. Post-installed steel anchors and fasteners.
   3. Appurtenances for anchoring and fastening.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary.

B. American National Standards Institute (ANSI):
   1. B212.15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.

C. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   2. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
   3. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. A240 - Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   6. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   7. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   8. B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
   9. E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.
   10. F436 - Standard Specification for Hardened Steel Washers.
   11. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
   12. F594 - Standard Specification for Stainless Steel Nuts.

13. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
14. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

E. International Code Council Evaluation Service, Inc. (ICC-ES):
1. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.
2. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.
3. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 45 degrees above a horizontal line so the fastener resists sustained tension loads.
4. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.
5. Post-installed anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.
6. Terms relating to structures or building environments as used with reference to anchors and fasteners:
    a. Corrosive locations: Describes interior and exterior locations as follows:
        1) Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
        2) Exterior and interior locations at the following treatment structures:
            a) Wastewater treatment facilities: Solids stream:
                (1) Sludge storage tanks.
    b. Wet and moist locations: Describes locations, other than "corrosive locations," that are submerged, are immediately above liquid containment structures, or are subject to frequent wetting, splashing, or wash down. Includes:
        1) Exterior portions of buildings and structures.
        2) Liquid-containing structures:
            a) Locations at and below the maximum operating liquid surface elevation.
            b) Locations above the maximum operating liquid surface elevation and:
                (1) Below the top of the walls containing the liquid.
                (2) At the inside faces and underside surfaces of a structure enclosing or spanning over the liquid (including walls, roofs, slabs, beams, or walkways enclosing the open top of the structure).

3) Liquid handling equipment:
   a) Bases of pumps and other equipment that handles liquids.
4) Indoor locations exposed to moisture, splashing, or routine wash down during normal operations, including floors with slopes toward drains or gutters.
5) Other locations indicated on the Drawings.

c. Other locations:
1) Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Calculations.

1.05 SUBMITTALS

A. General:
1. Submit as specified in Section 01_33_00 - Submittal Procedures and Section 01_60_00 - Product Requirements.

B. Product data:
1. Cast-in anchors:
   a. Manufacturer's data, including catalog cuts showing anchor sizes and configuration, materials, and finishes.
2. Post-installed anchors:
   a. For each anchor type, manufacturer's data, including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.

C. Delegated Design Submittals:
1. When requesting product substitutions for post installed anchors, submit calculations, indicating the diameter, effective embedment depth and spacing of the proposed anchors, and demonstrating that the substituted product will provide load resistance that is equal to or greater than that provided by the anchors listed in this Section.

D. Samples:
1. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.

E. Certificates:
1. Cast-in anchors:
   a. Mill certificates for steel anchors that will be supplied to the Site.
2. Post-installed anchors:
   a. Manufacturer's statement or certified test reports demonstrating that anchors that will be supplied to the Site comply with the materials properties specified.

F. Test reports:
    1. Post-installed anchors: For each anchor type used for the Work:
        a. Current ICC-ES Report (ESR), or equivalent acceptable to the Engineer and the authority having jurisdiction, demonstrating:
            1) Acceptance of that anchor for use under the building code specified in Section 01_41_00 - Regulatory Requirements.
            2) That testing of the concrete anchor included the simulated seismic tension and shear tests of AC193, and that the anchor is accepted for use in Seismic Design Categories C, D, E, or F, and with cracked concrete.
    2. Concrete anchor pre-installation test report.

G. Manufacturer's instructions:
    1. Requirements for storage and handling.
    2. Recommended installation procedures, including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
    3. Requirements for inspection or observation during installation.

H. Qualification statements:
    1. Post-installed anchors: Installer qualifications:
        a. Submit list of personnel performing installations. Include letter of training from manufacturer indicating date of manufacturer's training for each installer.

1.06 QUALITY ASSURANCE

A. Qualifications:
    1. Post installed anchors shall be in accordance with building code specified in Section 01_41_00 - Regulatory Requirements.
    2. Installers: Post-installed mechanical anchors:
        a. Conduct a training session with the manufacturer's authorized technical representative for the Project on site:
            1) Training shall cover the complete installation process for each type of anchor to be used and shall include, but not be limited to, hole drilling procedures and techniques, hole preparation and cleaning, bolt installation, and bolt proof loading and torquing.
            2) Use only trained and qualified personnel for anchor installation.
        b. Installations shall be performed by trained installers having at least 3 years of experience performing similar installations with similar types of anchors.

B. Special inspection:
    1. Provide special inspection of post-installed anchors as specified in Section 01_45_24 - Regulatory Quality Assurance and this Section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements.

B. Deliver post-installed anchors in manufacturer's standard packaging with labels visible and intact. Include manufacturer's installation instructions.

C. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.

D. Protect anchors from weather and moisture until installation.

1.08 PROJECT CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. General:
   1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor.
      a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
      b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
   2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings or as specified in this Section. In the event of conflicts, contact the Engineer for clarification.
   3. Where anchors and connections are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.

B. Materials:
   1. Provide and install anchors of materials as specified in this Section.

2.02 CAST-IN ANCHORS AND FASTENERS

A. Anchor bolts:
   1. Straight steel rod having one end with an integrally forged head, and one threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.
   2. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to the Engineer.
      a. Rods or bars with angle bend for embedment in concrete (i.e., "L" or "J" shaped anchor bolts) are not permitted in the Work.
   3. Materials:
      a. Ship anchor bolts with properly fitting nuts attached.

b. Type 316 stainless steel:
    1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
    2) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
    3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    4) Washers: Type 316 stainless steel.
c. Type 304 stainless steel:
    1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
    2) Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
    3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    4) Washers: Type 304 stainless steel.
d. Galvanized steel:
    1) Hot-dip galvanized coating in accordance with ASTM F2329.
    2) Bolts: ASTM F1554, Grade 36, heavy hex, coarse thread.
    3) Nuts: ASTM A563, Grade A heavy hex, threads to match bolt.
    4) Washers: ASTM F436, Type 1.

B. Anchor rods:
1. Straight steel rod having threads on each end or continuously threaded from end to end. One threaded end is fitted with nuts or plates and embedded in concrete to the effective depth indicated on the Drawings, leaving the opposite threaded end to project clear of the concrete face as required for the connection to be made at that location.
2. Materials:
    a. Stainless steel: Type 316:
        1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
        2) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
        3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of rods.
        4) Washers: Type 316 stainless steel.
        5) Plates (embedded): ASTM A240.
    b. Stainless steel: Type 304:
        1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
        2) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
        3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads or rods.
        4) Washers: Type 304 stainless steel.
        5) Plates (embedded): ASTM A240.
    c. Galvanized steel:
        1) Hot-dip galvanized with coating in accordance with ASTM F2329.
        2) Rod: ASTM F1554, Grade 36, coarse thread.
        3) Nuts: ASTM A563, Grade A, threads to match rod.
        4) Washers: ASTM F436, Type 1.
        5) Plates (embedded): ASTM A36.

C. Concrete insert: Ductile embed:
   1. 1-piece, integrally hot forged sleeve for embedment in concrete. Provided with flange for nailing to forms and female threaded coupler at the exposed concrete face, and washer-faced hex headed foot to resist pullout from concrete at the embedded end.
   2. Manufacturers: The following or equal:
      a. Dayton Superior, F-54 Ductile Embed Insert.
   3. Materials:
      a. Galvanized steel:
         1) Hot-dip galvanized coating in accordance with ASTM A123 or ASTM A153 where indicated on the Drawings.
         2) Steel: ASTM A29 hot rolled, Grade 1045.

D. Welded studs:
   1. Anchor with forged head for embedment into concrete on one end, and welding ferrule for attachment to steel on the other. Welded to steel members or plates to provide anchorage for steel connections to concrete.
   2. Shall be in accordance with AWS D1.1, Type B.
   3. Manufacturers: One of the following or equal:
      a. Nelson Stud Welding (Stanley Engineered Fastening), H4L Concrete Anchors or S3L Shear Connectors as indicated on the Drawings.
      b. Stud Welding Products, Headed Concrete Anchors (HCA) or Headed Shear Connectors (HSC) as indicated on the Drawings.
   4. Materials:
      a. Stainless steel: Type 316L.
      b. Stainless steel: Type 304L.
      c. Galvanized steel:
         1) Hot-dip galvanized after fabrication with coating in accordance with ASTM A123.
         2) Steel: Low carbon steel in accordance with ASTM A29/A108 with 51,000 pounds per square inch minimum yield strength, and65,000 pounds per square inch minimum tensile strength.

2.03 POST-INSTALLED ANCHORS AND FASTENERS - ADHESIVE

A. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in concrete: As specified in Section 03_21_17 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

2.04 POST-INSTALLED ANCHORS AND FASTENERS - MECHANICAL

A. General:
   1. Post-installed anchors shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01_41_00 - Regulatory Requirements. Reports prepared by other recognized evaluation agencies may be submitted for consideration if acceptable to the Engineer and to the authority having jurisdiction.
      a. Acceptance report shall indicate acceptance of the product for use under the following conditions:
         1) In regions of concrete where cracking has occurred or may occur.

2) To resist short-term loads due to wind forces.
3) To resist short-term loading due to seismic forces for the Seismic Design Category of the structure where the product will be used.

B. Concrete anchors:
1. Post-installed anchor assembly consisting of a threaded stud and a surrounding wedge expansion sleeve that is forced outward by torquing the center stud to transfer loads from the stud to the concrete through bearing, friction, or both. Sometimes referred to as “expansion anchors” or “wedge anchors.”
a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials to develop holding power.
2. Concrete expansion bolts for anchorage to concrete:
a. Shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
b. Performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
c. Manufacturers: One of the following:
1) DEWALT/Powers, PowerStud.
2) Hilti, Kwik Bolt TZ2 Wedge Anchor.
3) Simpson Strong-Tie, Strong-Bolt 2 Wedge Anchor.
d. Materials. Integrally threaded stud, wedge, washer, and nut:
1) Stainless steel: Type 316.
a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.
2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

C. Flush shells:
1. Post-installed anchor assembly consisting of an internally threaded mandrel that is forced into a pre-drilled concrete hole with a setting tool until the top of the anchor is flush with the face of the concrete. Once installed, a removable threaded bolt is installed in the mandrel.
2. Flush shell anchors are not permitted in the Work.

2.05 APPURTENANCES FOR ANCHORING AND FASTENING

A. Anchor bolt sleeves:
1. Fabricated steel sleeves:
a. Construct as specified in Section 05_50_00 - Metal Fabrications.
b. Fabricate to the following dimensions unless otherwise indicated on the Drawings:
1) Inside diameter: At least 2 inches greater than bolt diameter.
2) Inside length: Not less than 10-bolt diameters.

3) Bottom plate:
a) Square plate with dimensions equal to the outside diameter of the sleeve plus 1/2 inch each side.
b) Thickness equal to or greater than one-half of the anchor bolt diameter.

c. Carbon steel:
1) Fabricated from ASTM A36 plate and ASTM A53, Grade B pipe.
2) Welded connections: Conform to requirements of AWS D1.1.
3) Hot dip galvanized in accordance with ASTM A153.

d. Stainless steel:
1) Fabricated from ASTM A240 plate and pipe. Type 304L or Type 316L to match type of the anchor bolt.
2) Welded connections: In accordance with AWS D1.6.

B. Isolating sleeves and washers:
1. Manufacturers: One of the following or equal:
a. Allied Corrosion Industries.
b. Central Plastics Co.
2. Sleeves: Mylar, 1/32-inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending half way into both steel washers.
3. One sleeve required for each bolt.
4. Washers: Inside diameter of washers shall fit over the isolating sleeve, and both the steel and isolating washers shall have the same inside diameter and outside diameter.
a. Proper size to fit bolts.
b. Two 1/8-inch thick steel washers for each bolt.
c. G3 Phenolic: 2 insulating washers are required for each bolt:
1) Thickness: 1/8 inch.
2) Base material: Glass.
3) Resin: Phenolic.
4) Water absorption: 2 percent.
5) Hardness (Rockwell): 100.
6) Dielectric strength: 450 volts per mil.
7) Compression strength: 50,000 pounds per square inch.
8) Tensile strength: 20,000 pounds per square inch.
9) Maximum operating temperature: 350 degrees Fahrenheit.

C. Coating for repair of galvanized surfaces:
1. Manufacturers: The following or equal:
a. Jelt, Galvinox.

D. Thread coating: For use with threaded stainless steel fasteners:
1. Manufacturers: One of the following or equal:
a. Bostik, Never-Seez.
b. Oil Research, Inc., WLR No. 111.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION - GENERAL

A. Where anchors and fasteners are not specifically indicated on the Drawings or specified, make attachments with materials specified in this Section.

B. Substitution of anchor types:
   1. Post-installed anchors may not be used as an alternative to cast-in/built-in anchors at locations where the latter are indicated on the Drawings.
   2. Cast-in/built-in anchors may be used as an alternative to post-installed mechanical anchors at locations where the latter are indicated on the Drawings.

C. Protect products from damage during installation. Protect threads and threaded ends.

D. Accurately locate and position anchors and fasteners:
   1. Unless otherwise indicated on the Drawings, install anchors perpendicular to the surfaces from which they project.
   2. Install anchors so that at least 2 threads, but not more than 1/2 inch of threaded rod, projects past the top nut.

E. Interface with other products:
   1. Where steel anchors come in contact with dissimilar metals (aluminum, stainless steel, etc.), use stainless steel anchors and separate or isolate dissimilar metals using isolating sleeves and washers.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

3.03 INSTALLATION - CAST-IN ANCHORS

A. General:
   1. Accurately locate cast-in and built-in anchors.
      a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.
      b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.
      c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not “stab” anchors into plastic concrete, mortar, or grout.
      d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.

2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
3. Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.

B. Anchor bolts:
1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.
2. Where indicated on the Drawings, set anchor bolts in galvanized steel or stainless steel sleeves to allow for adjustment.
a. Fill sleeves with grout when a machine or other equipment is grouted in place.

C. Concrete inserts:
1. Provide inserts with minimum clear concrete cover not less than that specified for reinforcing bars.

D. Welded studs:
1. Butt weld to steel fabrications with automatic stud welding gun as recommended by the manufacturer.
2. Ensure that butt weld develops full strength of the stud.

3.04 INSTALLATION - POST-INSTALLED ADHESIVE ANCHORS

A. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in concrete: As specified in Section 03_21_17 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

3.05 INSTALLATION - POST-INSTALLED MECHANICAL ANCHORS

A. General:
1. Install anchors in accordance with the manufacturer’s instructions, ACI 355.2, the anchor’s ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements specified in this Section, the requirements of the ICC-ES Report shall control.
2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.
3. After anchors have been positioned and inserted into concrete or masonry, do not:
a. Remove and reuse/reinstall anchors.
b. Loosen or remove bolts or studs.

B. Holes drilled into concrete and masonry:
1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength (f’c or f’m).
2. Accurately locate holes:
a. Before drilling holes, use a reinforcing bar locator to identify the position of reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.

b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.

3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry.
   a. If embedments are encountered during drilling, immediately stop work and notify the Engineer. Await the Engineer's instructions before proceeding.
4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.
5. Drill using anchor manufacturer's recommended equipment and procedures:
   a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
      1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
      2) Drill bits: Carbide-tipped in accordance with ANSI B212.15. Hollow drills with flushing air systems are preferred.
6. Drill holes at manufacturer's recommended diameter and to depth required to provide the effective embedment indicated.
7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor.
   a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
   b. Repeat cleaning process as required by the manufacturer's installation instructions.
   c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

C. Insert and tighten (or torque) anchors in compliance with the manufacturer's installation instructions.
   1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Concrete Anchors			
	Minimum Effective Embedment Length		Minimum Member Thickness
Nominal Diameter	In Concrete	In Grouted Masonry	
3/8 inch	2-1/2 inch	2-5/8 inch	8 inch
1/2 inch	3-1/2 inch	3-1/2 inch	8 inch
5/8 inch	4-1/2 inch	4-1/2 inch	10 inch
3/4 inch	5 inch	5-1/4 inch	12 inch

E. Flush shell anchors:
   1. Not permitted in the Work.
   2. If equipment manufacturer's installation instructions recommend the use of flush shell anchors, contact the Engineer for instructions before proceeding.

3.06 FIELD QUALITY CONTROL

A. Provide quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control.
   1. Expenses associated with Work described by the following paragraphs shall be paid by the Contractor.

B. Post-installed anchors:
   1. Review anchor manufacturer's installation instructions and requirements of the Evaluation Service Report (hereafter referred to as "installation documents") for each anchor type and material.
   2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
   3. Certify in writing that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.07 FIELD QUALITY ASSURANCE

A. Owner's representative will provide on-site observation and field quality assurance for the Work of this Section.
   1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.

B. Field inspections and special inspections:
   1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted Submittals, and the manufacturer's installation instructions for the products used.
   2. Record of inspections:
      a. Maintain record of each inspection.
      b. Submit copies to the Engineer upon request.
   3. Statement of special inspections: At the end of the Project, prepare and submit to the Engineer and the authority having jurisdiction inspector's statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.

C. Special inspections: Anchors cast into concrete and built into masonry.
   1. Provide special inspection during positioning of anchors and placement of concrete or masonry (including mortar and grout) around the following anchors:
      a. Anchor bolts.
      b. Concrete inserts (all types).
      c. Welded studs.
   2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents.
      a. Anchor:
         1) Type and dimensions.
         2) Material: Galvanized steel, Type 304 stainless steel or Type 316 stainless steel, as specified in this Section or indicated on the Drawings.

3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.

3. Following hardening and curing of the concrete or masonry surrounding the anchors, provide periodic special inspection to observe and confirm the following:
   a. Base material (concrete or grouted masonry):
      1) Solid and dense concrete or grouted masonry material within required distances surrounding anchor.
      2) Material encapsulating embedment is dense and well-consolidated.

D. Special inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry.
   1. Provide special inspection during installation of the following anchors:
      a. Concrete anchors.
   2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torquing of anchors.
      a. Provide continuous special inspection for post-installed anchors in “overhead installations” as defined in this Section.
   3. Requirements for periodic special inspection:
      a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for the anchor being used. Observe the initial installation of each type and size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours.
         1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor shall require a new “initial inspection.”
      b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor’s rated strength.
      c. Anchor:
         1) Manufacturer, type, and dimensions (diameter and length).
         2) Material (galvanized, Type 304 stainless steel, or Type 316 stainless steel).
      d. Hole:
         1) Positioning: Spacing and edge distances.
         2) Drill bit type and diameter.
         3) Diameter, and depth.
         4) Hole cleaned in accordance with the manufacturer’s required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
         5) Anchor’s minimum effective embedment.
         6) Anchor tightening/installation torque.
   4. Requirements for continuous special inspection:
      a. Special inspector shall observe all aspects of anchor installation, except that holes may be drilled in their absence provided that they confirm the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:
   1. Owner's Representative may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications.
      a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
      b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.

3.08 NON-CONFORMING WORK

A. Remove misaligned or non-performing anchors.

B. Fill empty anchor holes and repair failed anchor locations using high-strength, non-shrink, non-metallic grout.

C. If more than 10 percent of all tested anchors of a given diameter and type fail to achieve their specified torque or proof load, the Engineer will provide directions for required modifications. Make such modifications, up to and including replacement of all anchors, at no additional cost to the Owner.

3.09 SCHEDULES

A. Provide and install anchor materials as scheduled in the following table.

Required Anchoring Materials by Location			
Location/Exposure		**Materials**	**Notes**
1.	**Anchors into concrete and grouted masonry for attachment of carbon steel, including structural steel and other steel fabrications:**		
a.	Interior dry areas	Carbon steel - galvanized	
b.	Locations with galvanized steel structures or fabrications	Stainless steel - Type 304 or 316	1
c.	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
d.	Corrosive locations	Stainless steel - Type 316	1
2.	**Anchors into concrete and grouted masonry for attachment of aluminum, stainless steel, or fiber-reinforced plastic (FRP) shapes and fabrications:**		
a.	Interior dry areas	Stainless steel - Type 304 or 316	1
b.	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
c.	Corrosive locations	Stainless steel - Type 316	1
3.	**Anchors for attaching equipment and its appurtenances:**		
a.	All locations	Stainless steel - Type 316 (unless Type 304 is specifically indicated in the specifications for the equipment.)	1
Notes: (1) Where anchors are in contact with a metal that differs from that of the anchor, provide isolation sleeves and washers.			

END OF SECTION

SECTION 05_12_00

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Structural steel shapes and plate.
   2. Fasteners and structural hardware:
      a. All thread rods.
      b. High-strength bolts.
   3. Welding.
   4. Bolting.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. 303 - Code of Standard Practice for Steel Buildings and Bridges.
   2. 360 - Specification for Structural Steel Buildings.

B. American Iron and Steel Institute (AISI):
   1. Steel and stainless steel alloys (“types”) as indicated.

C. American Welding Society (AWS):
   1. A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   2. A5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   3. A5.20 - Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   4. D1.1 - Structural Welding Code - Steel.
   5. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   2. A36 - Standard Specification for Carbon Structural Steel.
   3. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   6. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   7. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

9. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
10. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
11. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
12. A992 - Standard Specification for Structural Steel Shapes.
13. B695 – Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
14. F436 - Standard Specification for Hardened Steel Washers.
15. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
16. F594 - Standard Specification for Stainless Steel Nuts.
17. F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
18. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
19. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

E. Research Council on Structural Connections (RCSC):
1. Specification for Structural Joints Using High-Strength Bolts (RCSC Specification).

1.03 DEFINITIONS

A. Snugtight: At bolted joints, the tightness attained with a few impacts of an impact wrench, or by the full effort of an ironworker using a spud wrench to bring the connected plies into firm contact.

B. Stainless steel related terms:
1. Descaling: Removal of heavy, tightly adherent oxide films resulting from hot-forming, heat-treatment, welding, and other high-temperature operations.
2. Pickling: Chemical descaling of stainless steel using aqueous solutions of nitric and hydrofluoric acid, or various proprietary formulations as specified.
3. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel’s protective passive film.

1.04 SUBMITTALS

A. Product data:
1. Welding electrodes: Electrode manufacturer's data.
2. Compressible-washer-type direct tension indicators: Manufacturer’s detailed installation instructions including:
a. Requirements for type and frequency of pre-installation verification.
b. Requirements for coordination with regular washers.
c. Instructions for assembling and tightening the joint so that work progresses from the most rigid part until the connected plies are in firm contact.

3. Stainless steel: Fabricator name and qualifications, member dimensions and structural section properties, and specifications and procedures used for pickling and passivating members.

B. Shop drawings:
   1. Fabrication and erection drawings.

C. Quality control submittals:
   1. Welding procedure specifications (WPS) in accordance with AWS D1.1 and D1.6.
      a. Submit WPS for each type of welded joint used, whether prequalified or qualified by testing.
         1) State electrode manufacturer and specific electrodes used.
         2) Indicate required AWS qualification for joint.
      b. Submit WPS with shop drawings that indicate those welds.
      c. Submit Procedure Qualification Record (PQR) in accordance with AWS D1.1 and D1.6 for welding procedures qualified by testing.
   2. Welder qualifications: For each welding process and position:
      a. Welder's qualification certificates.
      b. Contractor's statement that certificate will be "in effect" at the time(s) welding will be performed based on the "Period of Effectiveness" provisions of AWS D1.1 and D1.6.

D. Test reports:
   1. Certified copies of mill tests and analyses made in accordance with applicable ASTM standards, or reports from a recognized commercial laboratory, including chemical and tensile properties of each shipment of structural steel or part thereof having common properties.

1.05 QUALITY ASSURANCE

A. Welding:
   1. Perform welding of structural metals in accordance with AWS D1.1 and D1.6 using welders who have current AWS qualification certificate for the process, position, and joint configuration to be welded.
   2. Make Welding Procedure Specifications available at the locations where welding is performed.
   3. Notify Engineer at least 24 hours before starting shop or field welding.
   4. Engineer may check materials, equipment, and qualifications of welders.
   5. Remove welders performing unsatisfactory Work, or require requalification.
   6. Engineer may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.
   7. Contractor shall bear costs of retests on defective welds.
   8. Contractor shall also bear costs in connection with qualifying welders.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver structural steel free from mill scale, rust, and pitting.

B. Storage and protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified or indicated on the Drawings, materials shall conform to the following:

Item	ASTM Standard	Class, Grade, Type, or Alloy Number
Carbon Steel		
Plate, bars, rolled shapes (except W and WT shapes), and miscellaneous items	A36	--
Rolled W and WT shapes	A992	Grade 50
Hollow structural sections/HSS: Round, square, or rectangular (including “pipe” where indicated for structural members and supports)	A500	Grade C
Stainless steel		
Plate, sheet, and strip	A240	Type 304(1) or 316(2)
Bars and shapes	A276	Type 304(1) or 316(2)
Notes: (1) Use Type 304L (low-carbon stainless steel) if material will be welded. (2) Use Type 316L (low carbon stainless steel) if material will be welded.		

2.02 FASTENERS AND STRUCTURAL HARDWARE

A. General:
   1. Materials: Of domestic manufacture.
   2. Where fasteners and hardware are specified to be galvanized, hot-dip galvanize in accordance with ASTM A153 or ASTM F2329, unless otherwise specified.

B. All thread rods:
   1. Carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings.
      b. Nuts: ASTM A194.
      c. Washers: ASTM F436.
   2. Galvanized carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings, and hot dip galvanized in accordance with ASTM A153.
      b. Nuts: ASTM A194, hot-dip galvanized in accordance with ASTM A153.
      c. Washers: ASTM F436, hot-dip galvanized in accordance with ASTM A153.
   3. Stainless steel:
      a. Units descaled, pickled, and passivated as specified in “Fabrication” in this Section.

b. Threaded rods and nuts to be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship all thread rods with properly fitting nuts attached.
c. Alloy Type 304 or Type 316 as indicated on the Drawings.
d. Type 304:
1) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
3) Washers: Type 304 stainless steel.
e. Type 316:
1) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
3) Washers: Type 316 stainless steel.

C. Anchor bolts, anchor rods, and post-installed steel anchors: As indicated on the Drawings and as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.

D. High-strength bolts:
1. Provide high-strength bolt assembly, with nuts, hardened flat washers, and compressible-washer-type direct tension indicators.
2. Carbon steel - Uncoated:
a. Bolts: Plain heavy hex structural bolts in accordance with ASTM F3125, Grade A325, Type 1.
b. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade C.
c. Washers:
1) Adjacent to normal, oversized, and short-slotted holes: Circular, square or rectangular beveled, clipped, or extra thick washers in accordance with ASTM F436, Type 1. Flat circular washers unless otherwise indicated on the Drawings.
2) Adjacent to long slotted holes: Fabricated from 5/16-inch thick plate conforming to ASTM A36.
d. Load indicator devices: At slip critical connections, provide one of the following devices at each bolt:
1) Compressible washer type direct tension indicators (“DTI”): In accordance with ASTM F959, Type 325-1.
2) Twist-off type tension-control bolt assemblies: ASTM F3125, Grade F1852.
3. Carbon steel - Galvanized:
a. Bolt and nut assemblies fabricated, galvanized, tested for rotational capacity, and shipped accordance with the provisions ASTM F3125, Grade A325and the RCSC Specification.
b. Bolts, nuts, and washers: Hot-dip galvanized in accordance with ASTM F2329.
c. Bolts: Plain heavy hex structural bolts in accordance with ASTM F3125, Grade A325, Type 1 and galvanized as specified.
d. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade DH, galvanized as specified, and lubricated in accordance with ASTM A563, Supplementary Requirement S1 to minimize galling.

e. Washers:
    1) Adjacent to normal, oversized, and short-slotted holes: Circular, square or rectangular beveled, clipped, or extra thick washers in accordance with ASTM F436, Type 1 and galvanized as specified. Flat circular washers unless otherwise indicated on the Drawings.
    2) Adjacent to long slotted holes: 5/16-inch thick plate washer fabricated from steel conforming to ASTM A36, and galvanized in accordance with ASTM A123.
f. Load indicator devices: At slip critical connections, provide one of the following devices at each bolt:
    1) Compressible washer type direct tension indicators (“DTI”): In accordance with ASTM F959, Type 325-1, with mechanically deposited zinc coating conforming to ASTM B695, Class 55.
    2) Twist-off type tension-control bolt assemblies: ASTM F3125, Grade F1852 with mechanically deposited zinc coating conforming to ASTM B695, Class 55.

E. Stainless steel bolts (for use in stainless steel structures):
1. General:
    a. Bolts and nuts shall be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship bolts with properly fitting nuts attached.
    b. Units descaled, pickled and passivated as specified in “Fabrication."
2. Alloy: Type 304 or Type 316 to match alloy of structural members being connected.
3. Type 304:
    a. Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
    b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    c. Washers: Type 304 stainless steel.
4. Type 316:
    a. Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
    b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    c. Washers: Type 316 stainless steel.

2.03 ISOLATING SLEEVES AND WASHERS

A. As indicated on the Drawings and as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.04 GALVANIZED SURFACE REPAIR

A. Manufacturers: The following or equal:
1. Jelt, Galvinox.

2.05 THREAD COATING

A. Manufacturers: One of the following or equal:
1. Bostik, Never-Seez.
2. Oil Research, Inc., WLR No. 111.

2.06 SUPPLEMENTARY PARTS

A. Furnish as required for complete structural steel erection, whether or not such parts and Work are specified or indicated on the Drawings.

2.07 FABRICATION

A. Shop assembly:
   1. Fabricate structural steel in accordance with AISC 360 and AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
   2. Where anchors, connections, or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
   3. Round off sharp and hazardous projections and grind smooth.
   4. Take measurements necessary to properly fit work in the field. Take responsibility for and be governed by the measurements and proper working out of all the details.
   5. Take responsibility for correct fitting of metalwork.
   6. Welded connections:
      a. Comply with AWS requirements for the metals to be welded.
      b. Weld only in accordance with approved Welding Procedure Specifications.
      c. Keep Welding Procedure Specifications readily available for welders and inspectors during fabrication processes.

B. Stainless steel shapes and assemblies:
   1. For structural members such as W shapes, S shapes, channels, angles, and similar rolled shapes not available in quantity, size, and type of stainless steel specified or indicated on the Drawings:
      a. Fabricate shapes using laser-fused, full penetration welds between pieces of plate to attain same or higher section modulus and moment of inertia as that of members indicated on the Drawings.
      b. Fabricate shapes from dual grade stainless steel.
      c. Fabricate beams and channels to ASTM A6 tolerances.
      d. Manufacturers: The following or equal:
         1) Stainless Structural, LLC.
   2. Cleaning and passivation:
      a. Following shop fabrication of stainless steel members and bolts, clean and passivate fabrications at point of manufacture.
      b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a bright passive finished surface with no etching, pitting, frosting, or discoloration.
      c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
         1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.

d. Pre-clean, chemically de-scale (“pickle”), passivate, and final-clean fabrications in accordance with the requirements of ASTM A380.
    1) If degreasing is required before cleaning (pickling) to remove scale or iron oxide, cleaning with citric acid treatments is permissible; however, such treatments shall be followed inorganic cleaners.
    2) Pickle and passivate stainless steel using a nitric acid solution in accordance with ASTM A380, Annex A2, Table A2.1, Part II.
    3) Pickling by citric acid treatment or sulfuric acid treatment is not considered to satisfy the requirements of this Section.
e. Inspect after cleaning using methods specified for “gross inspection” in ASTM A380.
f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the site.

C. Galvanized carbon steel:
1. Where galvanizing is required, hot-dip structural steel after fabrication in accordance with ASTM A123:
2. Do not electro-galvanize or mechanically-galvanize unless specified or accepted by Engineer.
3. Re-straighten galvanized items that bend or twist during galvanizing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 ERECTION

A. General:
1. Fabricate structural and foundry items to true dimensions without warp or twist.
2. Form welded closures neatly, and grind off smooth where weld material interferes with fit or is unsightly.
3. Install structural items accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.
4. Do not shift out of alignment, re-drill, re-shape, or force fit fabricated items.
5. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and level.
6. Rigidly support and brace structural items needing special alignment to preserve straight, level, even, and smooth lines. Keep structural items braced until concrete, grout, or dry pack mortar has hardened for 48 hours minimum.
7. Erect structural steel in accordance with AISC 303 unless otherwise specified or modified by applicable regulatory requirements.

8. Where anchors, connections, and other details of structural steel erection are not specifically indicated on the Drawings or specified, form, locate, and attach with equivalent in quality and workmanship to items specified.
9. Round off sharp or hazardous projections and grind smooth.
10. Coat steel items as specified in Section 09_96_01 - High-Performance Coatings.

B. Stainless steel. Take all necessary precautions to avoid iron contamination of stainless steel during delivery, storage, and handling.
   1. Segregate stainless steel from iron.
   2. Tools and handling devices.
      a. Do not use iron tools clamps, chokes, working surfaces, or brushes when fabricating, handling, and erecting stainless steel.
      b. Do not use tools that have been contaminated by contact with iron.
      c. Use stainless steel, polymer coated, or wood tools and handling equipment. Do not use tools that have been contaminated by contact with iron or steel.

C. Welding: General:
   1. Make welds full penetration type, unless otherwise indicated on the Drawings.
   2. Remove backing bars and weld tabs after completion of weld. Repair defective welds observed after removal of backing bars and weld tabs.

D. Welding: Carbon steel:
   1. General: In accordance with AWS D1.1:
      a. Weld ASTM A36 and A992 structural steel, and ASTM A500 and A501 structural tubing with electrodes in accordance with AWS A5.1, using E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes.
      b. Field repair cut or otherwise damaged galvanized surfaces to equivalent original condition using a galvanized surface repair.

E. Welding - stainless steel:
   1. General: In accordance with AWS D1.6.
   2. Field welding of stainless steel will not be permitted.
   3. Passivation of field-welded surfaces:
      a. Provide cleaning, pickling and passivating as specified under “Fabrications” of this Section. Clean using Derustit Stainless Steel Cleaner, or equal.

F. Interface with other products:
   1. Where steel members and fasteners come in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.

G. Fasteners: General:
   1. Install bolts to project 2 threads minimum, but 1/2 inch maximum beyond nut.
   2. Anchor bolts and anchor rods: Install as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      a. Unless otherwise specified, tighten nuts on anchor bolts and anchor rods specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry to the "snugtight" condition.
   3. All thread rods in drilled holes bonded to concrete with adhesive: Install as specified in Section 03_21_17 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

H. Fasteners: High-strength carbon steel bolts:
   1. Connections with high-strength bolts shall in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
   2. Provide pre-tensioned joints at bolted connections, except where slip-critical or snugtight connections are indicated on the Drawings.
   2. Joints: Slip-critical.
      a. Confirm that faying surfaces at connections are free of dirt and other foreign material, have been blast cleaned, and are free of coatings and inadvertent overspray in accordance with RCSC Specification.
      b. Furnish hardened flat washers in accordance with ASTM F436:
         1) On outer plies with slotted holes.
         2) When 1 or more plies of the connected material has a yield strength less than 40 ksi.
         3) Under element, nut, or bolt head, turned in tightening.
      c. Install tension indicator washers, placed in accordance with ASTM F959 Figure X1, to confirm adequate tightening of bolts.
      d. Tighten bolts to full pretension.
   3. Joints: Pre-tensioned.
      a. Joint preparation, assembly, and tightening shall be as specified for slip-critical connections, except that the requirements for un-coated faying surfaces shall not apply.
   5. Joints: Snugtight:
      b. Install bolts with washers where required in accordance with RCSC Specification.
      c. Tighten bolts to bring the connected plies into firm contact. Tightening shall progress systematically beginning with the most rigid part of the joint. More than 1 cycle through the bolt pattern may be required to achieve this condition.
      d. Verify adequate tightening of bolts by visual observation to confirm that washers have been installed at locations required in accordance with RCSC Specification, and that the plies of the connected parts have been brought into firm contact.

I. Fasteners: Stainless steel bolts:
   1. Connections shall be snugtight joints unless otherwise indicated on the Drawings.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.
   3. Rotate nuts using a slow, smooth action without interruptions. Avoid over-tightening.

3.03 FIELD QUALITY CONTROL

A. Provide quality control as specified in Section 01_45_00 - Quality Control.

3.04 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01_45_00 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01_45_24 - Regulatory Quality Assurance.

END OF SECTION

SECTION 05_14_05

STRUCTURAL ALUMINUM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Structural aluminum products, including sheet, pipe, extrusions, and associated accessories.

1.02 REFERENCES

A. American Welding Society (AWS):
   1. A5.10 - Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
   2. D1.2 - Structural Welding Code - Aluminum.

B. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

1.03 SUBMITTALS

A. Quality control Submittals:
   1. Test Reports: Certified copies of mill tests or reports from a recognized commercial laboratory including chemical and tensile properties of each shipment of structural metal or part thereof having common properties. Tests and analyses shall be made in accordance with applicable ASTM Standards.
   2. Welder’s certificates.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Perform welding of structural metals with welders who have current AWS certificate for the type of welding to be performed.
   2. Notify Engineer 24 hours minimum before starting shop or field welding.
   3. Engineer may check materials, equipment, and qualifications of welders.
   4. Remove welders performing unsatisfactory work or require to requalify.
   5. Engineer may use gamma ray, magnetic particle dye penetrant, or other aids to visual inspection to examine any part of welds or all welds.
   6. Contractor shall bear costs of retests on defective welds.
   7. Contractor shall bear costs in connection with qualifying welders.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural sheet aluminum: ASTM B209, Alloy 6061-T6.

B. Structural aluminum: ASTM B308, Alloy 6061-T6.

C. Extruded aluminum: ASTM B221, Alloy 6063-T42.

D. Isolating sleeves and washers:
   1. As indicated on the Drawings and as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.

E. Miscellaneous materials:
   1. Furnish supplementary parts necessary to complete each item even where such work is neither definitely indicated on the Drawings nor specified.
   2. Size, form, attachment, and location shall conform to the best of current practice.
   3. In accordance with applicable ASTM Standards for materials not otherwise specified.

2.02 FABRICATION

A. Aluminum layout:
   1. Center punch hole centers, and punch or scribe cutoff lines, except where marks would remain on fabricated material.
   2. Apply temperature correction where necessary in layout of critical dimensions. Use a coefficient of expansion of 0.000013 per degree of Fahrenheit.

B. Cutting aluminum:
   1. Material 1/2-inch thick or less: Shear, saw, or cut with a router.
   2. Material more than 1/2-inch thick: Saw or rout.
   3. Make cut edges true and smooth, free from excessive burrs or ragged breaks.
   4. Avoid reentrant cuts wherever possible. Where used, fillet by drilling prior to cutting.
   5. Do not flame cut aluminum alloys.
   6. Punch or drill rivet or bolt holes to finished size before assembly:
      a. Make finished diameter of holes for bolts 1/16-inch maximum larger than nominal bolt diameter.
      b. Make holes cylindrical and perpendicular to principal surface.
      c. Do not permit holes to drift in a manner to distort metal.

C. Aluminum forming and assembly:
   1. Do not heat structural aluminum, except as follows:
      a. Heat aluminum to 400 degrees Fahrenheit for 30 minutes maximum, to facilitate bending or welding.
      b. Heat only when proper temperature controls and supervision can ensure that limitations on temperature and time are observed.

D. Before assembly, remove chips lodged between contacting surfaces.

E. Welding aluminum:
   1. Perform welding of aluminum in accordance with AWS D1.2.
   2. Weld aluminum in accordance with the following:
      a. Preparation:
         1) Remove dirt, grease, forming or machining lubricants, and organic materials from areas to be welded by cleaning with a suitable solvent or by vapor degreasing.
         2) Additionally, etch or scratch brush to remove oxide coating just prior to welding when inert gas tungsten arc welding method is used.
         3) Oxide coating may not need to be removed if welding is performed by automatic or semi-automatic inert gas shielded metal arc.
         4) Suitably prepare edges to ensure 100 percent penetration in butt welds by sawing, chipping, machining, or shearing. Do not cut with oxygen.
      b. Filler metal: Aluminum alloys in accordance with AWS A5.10 and AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
      c. Perform welding of structures which are to be anodized using filler alloys which will not discolor when anodized, AWS ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
      d. Perform welding by using a non-consumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG).
      e. Do not use welding process that requires use of a welding flux.
      f. Neatly make welded closures.
      g. Where weld material interferes with fit or is unsightly in appearance, grind it smooth.
      h. Make welds full penetration welds unless otherwise indicated on the Drawings.

2.03 FINISHES

A. Coating for Aluminum in contact with concrete or masonry:
   1. Epoxy mastic.
      a. As specified in Section 09_96_01 - High-Performance Coatings, coating system EPX-M-5.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION

A. Install structural aluminum products as indicated on the Drawings and specified.

B. Install structural aluminum products accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.

C. Do not cock out of alignment, redrill, reshape, or force fit fabricated items.

D. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and true to level.

E. Rigidly support and brace structural products needing special alignment to preserve straight, level, even, smooth lines, and keep braced until concrete, grout, or dry pack mortar has hardened for a minimum 48-hour period.

F. Interface with other products:
   1. Where aluminum comes in contact with dissimilar metals, use stainless steel bolts or anchors and separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.
   2. Coat those parts of aluminum that will be cast into concrete or that will be in contact with concrete, grout, masonry, wood, or other materials that will cause the aluminum to corrode, as specified in Section 09_96_01 - High-Performance Coatings.

END OF SECTION

SECTION 05_50_00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Aluminum grating stair tread.
   2. Aluminum stair nosing.
   3. Cast iron stop plank grooves.
   4. Concrete inserts.
   5. Handrails and guardrails.
   6. Ladders.
   7. Manhole frames and covers.
   8. Metal gratings.
   9. Metal tread plate.
   10. Preformed channel pipe supports.
   11. Stairs.
   12. Miscellaneous metals.
   13. Associated accessories to the above items.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. DAF-45: Designations from Start to Finish.
      a. M12-C22-A41.

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

C. American Welding Society (AWS):
   1. A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A48 - Standard Specification for Gray Iron Castings.
   3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
   4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   5. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels for General Applications.
   6. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   7. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
9. A489 - Standard Specification for Carbon Steel Lifting Eyes.
10. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
12. A635 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
13. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
14. A992 - Standard Specification for Structural Steel Shapes.
15. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
16. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
18. B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
20. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

E. National Association of Architectural Metal Manufacturers (NAAMM):
1. Metal Finishes Manual.

F. Occupational Safety and Health Administration (OSHA).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. Passivation: Removal of exogenous iron or iron compounds from the surface of a stainless steel by means of chemical dissolution resulting from treatment with an acid solution that removes the surface contamination but does not significantly affect the stainless steel itself.

1.04 SUBMITTALS

A. Product data:
1. Aluminum grating stair tread.
2. Aluminum stair nosing.
3. Cast iron stop plank grooves.
4. Handrails and guardrails.
5. Manhole frames and covers.
6. Metal grating.

B. Shop Drawings:
   1. Handrails and guardrails:
      a. Including details on connection attachments, gates, kick plates, ladders, and angles.
      b. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
      c. Include erection drawings, elevations, and details where applicable.
      d. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   2. Ladders.
   3. Metal grating.
   4. Metal tread plate.
   5. Stairs.
   6. Miscellaneous metals.

C. Samples:
   1. Guardrails with specified finishes.

D. Quality Control Submittals:
   1. Design data.
   2. Test reports:
      a. Guardrails: 3 copies of certified tests performed by an independent testing laboratory certifying that guardrails meet current state and OSHA strength requirements.
      b. Gratings:
         1) Grating manufacturers' calculations showing that gratings will meet specified design load, stress, and deflection requirements for each size grating for each span.
         2) Reports of tests performed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals in accordance with the standards of the ASTM, including the following:

Item	ASTM Standard No.	Class, Grade Type, or Alloy No.
Cast Iron		
Cast iron	A48	Class 40B
Steel		
Galvanized sheet iron or steel	A653	Coating G90
Coil (plate)	A635	--
Structural plate, bars, rolled shapes, and miscellaneous items (except W shapes)	A36	--
Rolled W shapes	A992	Grade 50

Item	ASTM Standard No.	Class, Grade Type, or Alloy No.
Standard bolts, nuts, and washers	A307	--
High strength bolts, nuts, and hardened flat washers	F3125, Grade A325	--
Eyebolts	A489	Type 1
Tubing, cold-formed	A500	--
Tubing, hot-formed	A501	--
Steel pipe	A53	Grade B
Stainless Steel		
Plate, sheet, and strip	A240	Type 304(1) or 316(2)
Bars and shapes	A276	Type 304(1) or 316(2)
Bolts (Type 304)	F593	Group 1 Condition CW
Bolts (Type 316)	F593	Group 2 Condition CW
Aluminum		
Flashing sheet aluminum	B209	Alloy 5005-H14, 0.032 inches minimum thickness
Structural sheet aluminum	B209	Alloy 6061-T6
Structural aluminum	B209, B308	Alloy 6061-T6
Extruded aluminum	B221	Alloy 6063-T42
Notes: (1) Use Type 304L if material will be welded. (2) Use Type 316L if material will be welded.		

1. Stainless steels are designated by type or series defined by ASTM.
2. Where stainless steel is welded, use low-carbon stainless steel.

2.02 MANUFACTURED UNITS

A. Aluminum grating stair tread:
   1. Manufacturers: One of the following or equal:
      a. Harsco Industrial IKG, Aluminum Grating Stair Tread with Mebac® nosing.
      b. McNichols Co., Type A-Standard with corrugated angle nosing.
   2. Material: Welded aluminum grating tread with non-slip nosing and integral end plates for bolt on attachment to stair stringers.
   3. Size:
      a. Tread width: To equal tread spacing plus 1 inch minimum.
      b. Tread length: Length to suit stringer-to-stringer dimension indicated on the Drawings.
      c. Depth: 1-3/4 inches.
   4. Bolts: Type 316 stainless steel.

B. Aluminum stair nosing:
   1. Manufacturers: One of the following or equal:
      a. American Safety Tread Co., Inc., Style 801 nosing.
      b. Wooster Products, Inc., Type 101 nosing.
   2. Material: Cast aluminum abrasive nosings with aluminum oxide granules integrally cast into metal, forming permanent, nonslip, long-wearing surface.
   3. For installation in cast-in-place stairs.
   4. Configuration: 4 inches wide, fabricated with integrally cast stainless steel anchors at approximately 12-inch centers. Length to extend within 3 inches of stair edge on each side.

C. Cast iron stop plank grooves:
   1. Manufacturers: One of the following or equal:
      a. McKinley Iron Works, Type L.
      b. Neenah Foundry Co., R-7500 Series, Type A.
   2. Size: 2-inch wide groove opening by 1-1/2 inch deep, unless otherwise indicated on the Drawings.
   3. Recess groove with the cast iron surface of the groove set flush with the concrete surface.

D. Concrete inserts:
   1. For supporting pipe and other applications are specified in Section 40_05_07.01 - Pipe Supports.

E. Handrails and guardrails:
   1. General:
      a. Design and fabricate assemblies shall be in accordance with current local, state, and OSHA standards and requirements.
      b. Coordinate layout of assemblies and post spacings to avoid conflicts with equipment and equipment operators:
         1) Indicate on the Shop Drawings locations of such equipment.
         2) Highlight locations where railings cannot be made continuous, and obtain the Engineer’s directions on how to proceed before fabricating or installing railings.
   2. Aluminum handrails and guardrails (nonwelded pipe):
      a. Rails, posts, and fitting-assembly spacers:
         1) In accordance with ASTM B429, 6005, 6063 or 6105, minimum Schedule 40, extruded aluminum pipe of minimum 1.89-inch outside diameter and 0.14-inch wall thickness.
      b. Kick plates: 6061 or 6105 aluminum alloy.
      c. Fastenings and fasteners: As recommended or furnished by the manufacturer.
      d. Other parts: 6063 extruded aluminum, or F214 or F514.0 aluminum castings:
         1) Fabrications: In accordance with ASTM B209 or ASTM B221 extruded bars:
            a) Bases: 6061 or 6063 extruded aluminum alloy.
         2) Plug screws or blind rivets: Type 305 stainless steel.
            a) Other parts: Type 300 series stainless steel.

e. Finish of aluminum components:
1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting.
a) AA DAF-25 Specification M12-C22-A41: Mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
2) Pretreat aluminum for cleaning and removing markings before anodizing.
f. Fabrication and assembly:
1) Fabricate posts in single, unspliced pipe length.
2) Perform without welding.
3) Do not epoxy bond the parts.
4) Maximum clear opening between assembled railing components as indicated on the Drawings.
g. Manufacturers: One of the following or equal:
1) Craneveyor Corp. Enerco Metals, C-V Rail.
2) Golden Railings, Riveted System.
3) Moultrie Manufacturing Co., Wesrail.
3. Fastenings and fasteners: As recommended or furnished by the guardrail manufacturer for use with this system.

F. Ladders:
1. General:
a. Type: Safety type in accordance with local, state, and OSHA standards as minimum. Furnish guards for ladder wells.
b. Size: 18 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.
2. Aluminum ladders:
a. Material: 6063-T5 aluminum alloy.
b. Rungs:
1) 1-inch minimum solid square bar with 1/8-inch grooves in top and deeply serrated on all sides.
2) Capable of withstanding 1,000-pound load without failure.
c. Side rails: Minimum 4-inch by 1/2-inch flat bars.
d. Finish of aluminum components:
1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting.
a) AA DAF-45 Specification M12-C22-A41: Mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
2) Pretreat aluminum for cleaning and removing markings before anodizing.
e. Fabrication:
1) Welded construction, of size, shape, location, and details indicated on the Drawings.
2) For fixed ladders over 24 feet high, provide a fall prevention system designed in accordance with state and OSHA requirements.

f. Fall prevention system: Including, but not limited to, railing, brackets, clamps, 2 sleeves, and 2 belts, in accordance with OSHA safe climbing requirements:
    1) Manufacturers: One of the following or equal:
        a) North Consumer Products, Saf-T-Climb.
        b) Swager Communications, Climbers Buddy System.

G. Manhole frames and covers:
1. Material: Gray iron castings, in accordance with ASTM A48, Class 30-B.
2. Type: Heavy-duty traffic type, with combined minimum set weight of 265 pounds.
3. Machine horizontal and vertical bearing surfaces to fit neatly, with easily removable cover bearing firmly in frame without rocking.
4. Frame:
    a. Bottom flange type.
    b. Approximately 4-1/2-inches frame height.
    c. Dimensions as indicated on the Drawings.
        1) Minimum inside clear dimension may not be smaller than nominal diameter minus 2 inches.
5. Cover:
    a. Skid-resistant grid pattern design stamped with name of utility service provided by manhole, such as ELECTRICAL, SEWER, TELEPHONE, or WATER.
    b. Solid type without ventilation holes.
6. Finish: Unpainted.

H. Metal gratings:
1. General:
    a. Fabricate grating to cover areas indicated on the Drawings.
    b. Unless otherwise indicated on the Drawings, grating over an opening shall cover entire opening.
    c. Make cutouts in grating where required for equipment access or protrusion, including valve operators or stems, and gate frames.
    d. Band ends of grating and edges of cutouts in grating:
        1) End banding: 1/4 inch less than height of grating, with top of grating and top edge of banding flush.
        2) Cutout banding: Full-height of grating.
        3) Use banding of same material as grating.
        4) Panel layout: Enable installation and subsequent removal of grating around protrusions or piping.
        5) Openings 6 inches and larger: Lay out grating panels with edges of 2 adjacent panels located on centerline of opening.
        6) Openings smaller than 6 inches: Locate opening at edge of single panel.
        7) Where an area requires more than 1 grating section to cover area, clamp adjacent grating sections together at 1/4-points with fasteners acceptable to the Engineer.
        8) Fabricate steel grating sections in units weighing not more than 50 pounds each.

9) Fabricate aluminum grating sections in units of weighing not more than 50 pounds each.
10) Gaps between adjacent grating sections shall not be more than the clear spacing between bearing bars.

e. When requested by the Engineer, test 1 section of each size grating for each span length involved on the job under full load:
1) Furnish a suitable dial gauge for measuring deflections.

f. Grating shall be aluminum, unless otherwise specified or indicated on the Drawings.

2. Aluminum grating:
a. Material for gratings, shelf angles, and rebates: 6061-T6 or 6063-T6 aluminum alloy, except crossbars may be 6063-T5 aluminum alloy.
b. Shelf angle concrete anchors: Type 304 or Type 316 stainless steel.
c. Grating rebate rod anchors: 6061-T6 or 6063-T6 aluminum alloy.
d. Bar size and spacing: As determined by the manufacturer to enable grating to support design load.
e. Design live load: A minimum of 100 pounds per square foot uniform live load on entire grating area, but not less than the live load indicated on the Drawings for the area where grating is located.
f. Maximum fiber stress for design load: 12,000 pounds per square inch.
g. Maximum deflection due to design load: 1/240 of grating clear span.
h. Maximum spacing of main grating bars: 1-1/8 inches clear between bars.
i. Minimum grating height: 1-1/2 inches.
j. Manufacturers: The following or equal:
1) Harsco Industrial IKG, Swaged Aluminum I-Bar with striated finish.

3. Heavy-duty steel grating:
a. Fabricated from structural steel and designed in accordance with AASHTO Standard Specifications for Highway Bridges, using H-20 loading.
b. Hot-dip galvanized after fabrication in accordance with ASTM A123.
c. Manufacturers: One of the following or equal:
1) Reliance Steel Products Co., Heavy-Duty Steel Grating.
2) Seidelhuber Metal Products, Inc., equivalent product.

I. Metal tread plate:
1. Having a raised figured pattern on one surface to provide improved traction.

J. Preformed channel pipe supports:
1. As specified in Section 40_05_07.03 - Preformed Channel Pipe Support System.

K. Stairs:
1. Aluminum stairs:
a. Stringers: 6061-T6 aluminum alloy.
b. Stair treads:
1) Aluminum of same type specified under aluminum grating.
2) Of sizes indicated on the Drawings, and 1-3/4 inch minimum depth with cast abrasive type safety nosings.

c. Handrails and guardrails: Aluminum pipe specified under the aluminum handrails and guardrails (nonwelded pipe) article.
d. Fasteners: Type 304 or Type 316 stainless steel.

L. Miscellaneous aluminum:
    1. Fabricate aluminum products, not covered separately in this Section, in accordance with the best practices of the trade and field assemble by riveting or bolting.
    2. Do not weld or flame cut.

M. Miscellaneous cast iron:
    1. Tough, gray iron, free from cracks, holes, swells, and cold shuts.
    2. Quality such that hammer blow will produce indentation on rectangular edge of casting without flaking metal.
    3. Before leaving the foundry, clean castings and apply 16-mil dry film thickness coating of coal-tar epoxy, unless otherwise specified or indicated on the Drawings.

N. Miscellaneous stainless steel:
    1. Provide miscellaneous stainless steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
        a. Fabricate and install in accordance with the best practices of the trade.
    2. Cleaning and passivation:
        a. Following shop fabrication of stainless steel members, clean and passivate fabrications.
        b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a passive finished surface.
        c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
            1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
        d. Pre-clean, chemically descale (pickle), and final clean fabrications in accordance with the requirements of ASTM A380 to remove deposited contaminants before shipping.
            1) Passivation by citric acid treatment is not allowed.
                a) If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible; however, these treatments shall be followed by inorganic cleaners such as nitric-hydrofluoric acid.
            2) Provide acid descaling (pickling) in accordance with Table A1.1 of Annex A1 of ASTM A380.
            3) After pickling, final cleaning of stainless steel shall be in accordance with Part II of Table A2.1 of Annex A2 of ASTM A380.
        e. After cleaning, inspect using methods specified for “gross inspection” in ASTM A380.
        f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the job site.

O. Miscellaneous structural steel:
   1. Provide miscellaneous structural steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
      a. Fabricate and install in accordance with the best practices of the trade.

P. Isolating sleeves and washers:
   1. As indicated on the Drawings and as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Examine work in place to verify that it is satisfactory to receive the Work of this Section.
   2. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.02 INSTALLATION

A. General:
   1. Install products as indicated on the Drawings, and in accordance with Shop Drawings and the manufacturer's printed instructions, as applicable, except where specified otherwise.
   2. Interface between materials:
      a. Dissimilar metals: Where steel comes in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals.
         1) Make application so that the isolating or protective barrier is not visible in the completed construction.
         2) Isolating sleeves and washers: As specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      b. Aluminum in contact with concrete or masonry: Coat aluminum surfaces as specified in Section 09_96_01 - High Performance Coatings.
      c. Aluminum in contact with concrete or masonry.

B. Aluminum stair nosing:
   1. Install on treads of concrete stairs, including top tread on upper concrete slab.
   2. Omit where concrete is submerged.
   3. Cast in fresh concrete, flush with tread and riser faces. Install nosing in center of step.

C. Cast iron stop plank grooves:
   1. Recess stop plank grooves with cast iron surfaces of groove set flush with concrete surface.

D. Handrails and guardrails:
   1. General:
      a. Fasten pipe rails to fittings with Series 300 stainless steel pop rivets or flush set screws.

b. Make pipe cuts clean and straight, free of burrs and nicks, and square and accurate for minimum joint-gap.
c. Drill and countersink holes to proper size, as required for a tight flush fit of screws and other component parts.
d. Space attachment brackets as indicated in the manufacturer's instructions.

2. Aluminum pipe handrails and guardrails:
   a. During construction, keep exterior surfaces of handrails and guardrails covered with minimum 0.4 millimeters of heat shrink polyethylene film.
   b. Do not remove protective film before handrails and guardrails have been accepted by the Engineer or before other work in proximity of handrails and guardrails has been completed.
   c. Discontinue handrails and guardrails at lighting fixtures.
   d. Provide 1/8-inch diameter weep hole at base of each post.
   e. Space posts as indicated on the Drawings.
   f. Anchor posts into concrete by grouting posts into formed holes in concrete, into stainless steel sleeves cast in concrete; or bracket mount to face of concrete surfaces as specified and indicated on the Drawings.
   g. Space rails as indicated on the Drawings.
   h. Make adequate provision for expansion and contraction of kick plates and rails.
      1) Make provisions for removable sections where indicated on the Drawings.
   i. Make lower rails a single, unspliced length between posts, or continuous.
   j. Make top rails continuous whenever possible, and attach single, unspliced lengths to 3 posts minimum.
   k. Draw up fasteners tight with hand wrench or screw driver.
   l. Space attachment brackets as indicated on the Drawings or in the manufacturer's installation instructions.
   m. Completed installation shall have handrails and railings rigid and free of play at joints and attachments.
   n. Protect handrail and guardrail finish from scratches, gouges, dents, stains, and other damage.
   o. Replace damaged or disfigured handrails and guardrails with new.
   p. Shortly before final acceptance of the Work, and after removal of protective polyethylene film, clean handrails and guardrails with mild detergent or with soap and water.
      1) After cleaning, thoroughly rinse handrails and guardrails and wipe with soft cloth.
   q. Erect guardrail straight, level, plumb, and true to the positions as indicated on the Drawings. Correct deviations from true line of grade, which are visible to the eye.

E. Ladders:
   1. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.
   2. Where exit from ladder is forward over top rung, extend side rails 3 feet-3 inches minimum above landing, and return the rails with a radius bend to the landing.
   3. Where exit from ladder is to side, extend ladder 5 feet-6 inches minimum above landing and rigidly secure at top.
   4. Erect rail straight, level, plumb, and true to position indicated on the Drawings:
      a. Correct deviations from true line or grade which are visible to the eye.

F. Manhole frames and covers:
    1. Installation: As recommended by the manufacturer.

G. Metal gratings:
    1. General:
        a. Allow 1/8-inch maximum clearance between ends of grating and inside face of vertical leg of shelf angles.
        b. Horizontal bearing leg of shelf angles shall be 2 inches minimum.
        c. Install aluminum plate or angles where necessary to fill openings at changes in elevation and at openings between equipment and grating.
        d. Install angle stops at ends of grating.
        e. Installed grating shall not slide out of rebate or off support.
        f. Weld stops in place, unless otherwise specified or indicated on the Drawings.
        g. Top surfaces of grating sections adjacent to each other shall lie in same plane.
    2. Aluminum grating:
        a. Support on aluminum shelf angles or rebates.
    3. Heavy-duty steel grating:
        a. Support on hot-dip galvanized structural steel rebates embedded and anchored in concrete.
        b. Use for roadways, traffic areas, and where indicated on the Drawings.

H. Stairs:
    1. Install guard railings around stair wells as indicated on the Drawings or specified.

I. Stainless steel:
    1. Welding:
        a. Passivate field-welded surfaces:
            1) Provide cleaning, pickling and passivating as specified in this Section.
            2) Clean using Derustit stainless steel cleaner, or equal.

END OF SECTION

SECTION 06_10_00

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Carpentry normally not exposed to view, related metal items, and connectors.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
   2. B18.6.1 - Wood Screws (Inch Series).

B. American Softwood Lumber Standard (ASLS):
   1. PS 20 -Softwood Lumber, Product Standard.

C. ASTM International (ASTM):
   1. D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   2. F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

D. U.S. Department of Commerce (DOC):
   1. Voluntary Product Standard PS 1-07 - Structural Plywood.

E. West Coast Lumber Inspection Bureau (WCLIB):
   1. Standard No. 17 - Grading Rules for West Coast Lumber.

F. Western Wood Products Association (WWPA):
   1. Western Lumber Grading Rules.

1.03 SUBMITTALS

A. Shop Drawings.

B. Product data.

1.04 QUALITY ASSURANCE

A. Grade lumber in accordance with the following:
   1. Douglas fir and larch lumber:
      a. WCLIB grading rules.
      b. WWPA grading rules.
      c. ASLS PS 20.

B. Stamp each piece of lumber with grade, species, and size.

C. Identify each panel of softwood plywood with appropriate APA grade-trademark. Plywood shall be in accordance with DOC PS 1-07.

D. Grade lumber 2 inches, 3 inches, and 4 inches thick in accordance with ASLS PS 20. Identify with grade name and species only without reference to paragraph numbers.

E. Grade lumber 6 inches and larger under provisions of the WWPA.
   1. Identify with grade, species, and size.
   2. Equivalent members graded by WCLIB will be accepted unless specifically excluded.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Cover products for protection from damage and moisture.

B. Stack lumber to permit good air drying. Position separators at each layer and between soil and first layer.

PART 2 PRODUCTS

2.01 WOOD

A. Minimum lumber grade requirements for framing and sheathing:

Classification	Nominal Size	Species and Minimum Grade
Studs	2 by 3, 2 by 4	DF-L Number 2 or construction
	2 by 6, 2 by 8	DF-L Number 2
Roof Joists	2 by 6 through 2 by 14	DF-L Number 2
Floor Joists and Planking	2 by 6 through 2 by 14	DF-L Number 2
Headers, Beams, and Stringers	4 by 4 through 4 by 14	DF-L Number 1
	6 by 6 through 6 by 14	DF-L Number 1 (WWPA 70-11)
Posts and Timbers	6 by 6 and larger	DF-L Number 1
Boards	1 by	DF-L Construction
Framing Lumber	All sizes	DF-L Number 2
Blocking and Bridging	2 by 3 through 2 by 14	DF-L Number 3
Miscellaneous	All sizes	DF-L Number 2
DF-L = Douglas fir - Larch (North) Grouping		

B. Species shall be as specified, or any combination of species allowed by grading rules.

C. Lumber 4 inches thick and less: Seasoned or kiln-dried with maximum 19 percent moisture.

D. Lumber thicker than 4 inches: Seasoned to minimize warping and twisting.

E. Lumber surfaces: Surfaced on four sides (S4S) unless otherwise specified or indicated on the Drawings.

F. Lumber shall be free of bow, warp, or twist. Pieces with serious defects will be discarded regardless of grading.

G. Sills, cants, and nailers for fascia for roofing: Preservative pressure-treated Number 2 or better Douglas fir.

H. Roof nailers: Use preservative pressure-treated Number 2 or better Douglas fir nailers for gravel stops at edges of roof and at roof expansion joints. Match thickness of nailers and roof insulation.

I. Wood in contact with concrete or masonry: Pressure treated as specified in Section 06_14_72 - Preservative Pressure Treated Wood.

J. Fire-retardant treatment: As specified in Section 06_14_74 - Fire Retardant Treated Wood.

2.02 PLYWOOD

A. Structural plywood: DOC PS 1-09.

B. Plywood with edges or surfaces permanently exposed to weather: Exterior type with exterior type glue, Grade A-C.

C. Plywood roof sheathing: Exterior type with exterior type glue, of thickness and grade as indicated on the Drawings.

D. Plywood sheathing exposed at overhangs: Exterior type plywood with exterior type glue, Grade A-C or better.

E. Miscellaneous plywood: Exterior type plywood of thickness indicated on the Drawings, Grade A-C, or as otherwise indicated on the Drawings.

F. Plywood for roof diaphragms and shear walls: As indicated on the Drawings.

2.03 ROUGH HARDWARE

A. Fasteners:
   1. Nails: ASTM F1667, common wire nails or spikes with full head.
   2. Bolts, nuts, and studs: ASME B18.2.1, hot-dip galvanized.
   3. Washers: Hot-dip galvanized square or round steel plate washers, or malleable iron washers with following dimensions:
      a. Hot-dip galvanized square steel washers:

Bolt Diameter	Washer Dimensions
1/2 inch	2-1/2 by 2-1/2 by 1/4 inches
5/8 inch	2-1/2 by 2-1/2 by 1/4 inches
3/4 inch	2-3/4 by 2-3/4 by 5/16 inches

Bolt Diameter	Washer Dimensions
7/8 inch	3-1/4 by 3-1/4 by 5/16 inches
1 inch	3-3/4 by 3-3/4 by 3/8 inches

b. Hot-dip galvanized round steel washers:

Bolt Diameter	Washer Dimensions
1/2 inch	2-1/2 inch diameter by 1/4 inch
5/8 inch	2-3/4 inch diameter by 1/4 inch
3/4 inch	3 inch diameter by 5/16 inch
7/8 inch	3-1/2 inch diameter by 3/8 inch
1 inch	4 inch diameter by 7/16 inch

c. Round malleable iron washers:

Bolt Diameter	Washer Dimensions
1/2 inch	2-1/2 inch diameter by 1/4 inch
5/8 inch	2-3/4 inch diameter by 5/16 inch
3/4 inch	3 inch diameter by 7/16 inch
7/8 inch	3-1/2 inch diameter by 7/16 inch
1 inch	4 inch diameter by 1/2 inch

4. Lag screws: ASME B18.2.1, hot-dip galvanized.
5. Wood screws: ASME B18.6.1.
6. Nails, screws, bolts, plates, and other fasteners exposed to weather or on building exteriors shall be hot-dip galvanized or of Series 300 stainless steel.
7. Anchor bolts, concrete anchors, flush shells, and powder actuated fasteners: As specified in Section 05_12_00 - Structural Steel Framing.
8. Sheet metal connectors:
   a. Manufacturers: One of the following or equal:
      1) Simpson Strong-Tie Co., Inc.
      2) USP Structural Connectors.
   b. Material: Sheet steel, hot-dip galvanized after fabrication.
   c. Model numbers: As indicated on the Drawings.
   d. Nails, typical: Common, hot-dip galvanized.
   e. Nails, joist hanger: Special, hot-dip galvanized, providing full building code as specified in Section 01_41_00 - Regulatory Requirements, lateral load resistance values for common nails.

B. Miscellaneous hardware:
   1. Clamps, expansion screws, anchors, and plates: Standard products of established manufacturers of proper size and strength to adequately fasten, support, and maintain members in place.
   2. Hardware exposed to weather or on building exteriors: Hot-dip galvanized.

C. Building paper: ASTM D226, unperforated, No. 15 unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for installation of products as specified in Section 01_60_00 - Product Requirements.

3.02 GENERAL

A. Notch, cope, and miter meeting members so meeting members have full bearing without overcutting or undercutting.

B. Accurately cut, fit, and frame lumber.

3.03 SILLS AND PLATES

A. Install 2 layers of building paper under sills and members fasten to concrete or masonry.

B. Secure sills to foundation as indicated on the Drawings. When not indicated on the Drawings, anchor sills with 1/2-inch diameter hot-dip galvanized anchor bolts at 4-foot centers and within a minimum of 6 inches from each end of each member.

C. Set plates on top of masonry and concrete walls level and in same plane.

D. Anchor plates to masonry or concrete with anchor bolts of size and spacing indicated on the Drawings. Install anchor bolt within 6 inches of member ends.

E. Use cement grout, when necessary, to ensure full bedding and leveling of plates.

3.04 WALLS

A. Erect walls plumb and true to line.

B. Frame walls and partitions with studs of sizes and spacing indicated on the Drawings and at not greater than 16 inches on center.

C. Provide double studs at openings and triple studs at corners.

D. Provide double plates at top of wall studs, arranging to form continuous horizontal ties. Splice individual plates and stagger ends of double plates.

E. Provide two 2-by-6 lintels for openings up to 48 inches and two 2-by-8 lintels for openings from 48 inches to 72 inches.

F. Frame openings for large pipes and ducts and for receiving recessed work in partitions without cutting structural members.

G. Place nailing blocks and backing necessary for attachment of ground, trim, fixtures, and miscellaneous items. Cut, fur, and install backing required for plumbing and heating pipes, fixtures, and electrical work.

H. Provide fire retardant pressure-treated wood within metal-framed partitions and furring.

I. Provide blocking for attaching paneling, trim, and similar items to framing.

J. Do not cut wood beams or joists and plates in bearing walls for passage of pipes.

K. Coordinate requirements for sleepers for mechanical equipment and curb openings with work of other Sections for locations and sizes.

L. Firestopping:
   1. Where required by governing codes, install continuous row of fire stop blocking in stud walls and partitions at ceilings and floor levels and at maximum 10 feet spacing. Form complete and effective separation for entire width of wall or partition.
   2. Use fire stop blocking with minimum 2 inches nominal thickness and same width as studs.
   3. Fill openings in firestops with other firestopping materials specified in Section 07_84_00 - Firestopping.

3.05 ROUGH HARDWARE

A. Provide nailing as indicated on the Drawings or in accordance with Fastening Schedule specified in building code, as specified in Section 01_41_00 - Regulatory Requirements, whichever is more stringent. Do not use box and sinker nails.

B. Install bolts and other fastenings as indicated on the Drawings or in accordance with building code as specified in Section 01_41_00 - Regulatory Requirements, whichever is more stringent.

C. Prebore nail holes where required to avoid splitting of wood members. Remove and replace split pieces.

D. Prebore holes for screws and lag screws, then screw into place. When wood screws and lag screws are defective because they have been driven into place with hammer, replace wood members involved with new members.

E. Drill holes for bolts 1/32-inch larger than bolt shank unless otherwise indicated on the Drawings.

F. Perform final bolting after structural members have been properly aligned.

G. Place washers under heads of bolts and nuts and heads of lag screws bearing on wood. Align exposed bolts.

H. Power nailing will be permitted where nails are as specified and provided installation does not mar or damage wood members.
   1. Nails shall have full head.
   2. Do not overdrive nails.

I. Drive nail heads for plywood diaphragms flush with plywood surface. Where nails have been overdriven in plywood panel, remove and replace plywood, nails, and damaged supporting members.
   1. Use common nails unless otherwise indicated on the Drawings.

END OF SECTION

SECTION 06_14_72

PRESERVATIVE PRESSURE TREATED WOOD

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Preservative pressure treatment of wood for protection against decay and termites, including:
      a. Wood in direct contact with soil.
      b. Floor joists or structural flooring closer than 18 inches to exposed ground.
      c. Girders closer than 12 inches to exposed ground.
      d. Framing, including wood sheathing, that rests on exterior foundation walls less than 8 inches from exposed earth.
      e. Sills, sleepers, posts or columns in contact with concrete or masonry that is in direct contact with earth.
      f. Girder ends entering exterior masonry or concrete walls with less than 1/2-inch clear space on the top, sides, and end.
      g. Siding on the exterior of a building less than 6 inches from exposed ground.
      h. Wood subject to alternate wet and dry cycles.

1.02 REFERENCES

A. American Wood Protection Association (AWPA):
   1. C1 - All Timber Products - Preservative Treatment by Pressure Processes.
   2. C2 - Lumber, Timber, Bridge Ties, and Mine Ties - Preservative Treatment by Pressure Processes.
   3. C9 - Plywood - Preservative Treatment by Pressure Processes.
   4. M4 - Standard for the Care of Pressure-Treated Wood.
   5. P5 - Standard for Waterborne Preservatives.

B. Federal Specifications (FS):
   1. TT-W-571 - Wood Preservation: Treating Practices.

1.03 SUBMITTALS

A. Product data: Include identification of preservative properties, method of treatment, and expected service life.

B. ICC Evaluation Service, Inc., Evaluation Report meeting AC78-Acceptance Criteria for Copper-Quaternary Wood Preservative Treatment Systems.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Keep materials dry during delivery and storage. Protect materials against exposure to weather and from contact with damp or wet surfaces.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Preservative treatment materials:
   1. One of the following or equal:
      a. Chemical Specialties, Inc.
      b. Osmose, Inc.

2.02 PRESERVATIVE TREATMENT MATERIALS

A. Arsenic and chromium free ammonium copper quaternary (ACQ) preservative produced in accordance with ACQ Preserve Standard ACQ - 94 and in accordance with AWPA P5:
   1. Waterborne, nonstaining, nonblooming; free from crystals, flame-supporting residue, and properties detrimental to subsequent finishes when applied.

B. Cut members to shape or size prior to pressure treating whenever possible.

C. Apply preservative treatment in accordance with AWPA C1 and C2 to achieve penetration of minimum 1/4 inch with retainage of minimum treatment material in accordance with AWPA C2 for service conditions.

D. When pressure treated wood is cut, apply minimum of 2 saturating coats of same preservative as used in original pressure treatment on cut surface.

2.03 PRESERVATIVE TREATMENT

A. Shop pressure treat wood materials in accordance with FS TT-W-571.

B. Shop pressure treat materials requiring preservative treatment in closed cylinder in accordance with AWPA C2 for lumber and AWPA C9 for plywood. Retention of ACQ shall be as follows:
   1. For wood subject to alternate wet-dry cycles: 0.25 pounds per cubic foot.
   2. For wood in contact with concrete or masonry: 0.25 pounds per cubic foot.
   3. For wood within 18-inches of the ground: 0.25 pounds per cubic foot.
   4. For wood in constant contact with ground or water: 0.40 per cubic foot.

C. Redry wood to maximum moisture content of 19 percent.

PART 3 EXECUTION

3.01 SITE TREATMENT OF WOOD MATERIALS

A. Apply preservative treatment in accordance with the manufacturer’s instructions. Redry to 19 percent moisture content.

B. Treat site-sawn ends in accordance with AWPA M4. Allow preservative to cure prior to placing members.

C. Redry wood to maximum 19 percent moisture content.

D. Allow preservative to cure prior to placing members.

3.02 INSTALLATION

A. Install wood in accordance with related work.

B. Discard treated wood which might impair quality of carpentry.

C. Do not rip or mill fire retardant treated lumber. Permit end cuts and drilling of holes adjoining cuts only.

END OF SECTION

SECTION 06_14_74

FIRE RETARDANT TREATED WOOD

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fire retardant treated treatment for wood framing, decking, sheathing, and miscellaneous wood.

1.02 REFERENCES

A. American Wood Protection Association (AWPA):
   1. C20 - Structural Lumber-Fire Retardant Treatment by Pressure Processes.
   2. C27 - Plywood-Fire Retardant Treatment by Pressure Processes.

B. ASTM International (ASTM):
   1. D3201 -Standard Test Method of Hygroscopic Properties of Fire Retardant Wood and Wood Base Products.
   2. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

C. Federal Specifications (FS):
   1. MIL-L-19140E - Lumber and Plywood, Fire Retardant Treated.

D. National Fire Protection Association (NFPA):
   1. 255 - Standard Test Method for Surface Burning Characteristics of Building Materials.

E. Underwriters Laboratories, Inc. (UL):
   1. 723 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Product data: Include National Evaluation Service Report discussing fire-retardant, strength, corrosion, and hygroscopic properties.

B. Manufacturer’s installation instructions.

1.04 QUALITY ASSURANCE

A. Employ services of treatment plant which is currently licensed by the manufacturer of treatment material.

B. Carbon steel, galvanized steel, aluminum, copper, and red brass in contact with fire retardant treated wood shall not corrode more than 1 mil per year when tested in accordance with FS MIL-L-19140E.

C. Fire performance and strength properties of fire retardant treated wood shall be recognized by issuance of National Evaluation Service Report.

D. Fire-retardant treatment shall provide UL FR-S Classification.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Keep materials dry during delivery and storage. Protect materials against exposure to weather and from contact with damp or wet surfaces.

PART 2 PRODUCTS

2.01 MATERIALS

A. Type: Dricon, registered for use as wood preservative by the U.S. Environmental Protection Agency, and free of halogens, sulfates, ammonium phosphate, and formaldehyde.

B. Manufacturers: The following or equal:
   1. Koppers Co., or Koppers Co.'s licensed producer.

2.02 FIRE RETARDANT TREATMENT

A. Treat wood in accordance with instructions of the fire retardant treatment materials manufacturer and AWPA C20 for structural lumber or AWPA C27 for plywood.

B. After treatment, kiln dry lumber to maximum moisture content of 19 percent and plywood to maximum moisture content of 15 percent so that fire retardant treated wood has equilibrium moisture content of not more than 25 percent when tested in accordance with ASTM D3201 procedures at 95 percent relative humidity and 80 degrees Fahrenheit.

C. Stamp fire-retardant lumber and plywood with UL FR-S rating stamp certifying 25 or less flame spread and smoke developed value, when tested in accordance with UL 723, ASTM E84, or NFPA 255.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install wood in accordance with related work.

B. Discard treated wood which might impair quality of carpentry.

C. Do not rip or mill fire retardant treated lumber. Permit end cuts and drilling of holes adjoining cuts only.

END OF SECTION

SECTION 06_80_15

FIBERGLASS REINFORCED PLASTIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. General fabrication and design requirements for fiberglass reinforced plastic fabrications.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. ASTM International (ASTM):
   1. C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   2. D883 - Standard Terminology Relating to Plastics.
   3. D2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
   4. D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   5. D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.
   6. D3299 - Standard Specification for Filament-Wound Glass Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks.
   7. D4097 - Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Chopped glass: Fibrous material consisting of randomly oriented chopped filaments applied directly to a mold surface or laminated under construction by a chopper gun.
   2. Equipment: Fiberglass reinforced plastic equipment, including ancillary equipment, work, and materials as described in this Specification.
   3. Fabrication drawings: Those drawings produced by the fabricator or Contractor with the intention of providing the necessary information to construct or install the equipment.
   4. Fiber prominence (Jackstraw): Distinct visibility of individual glass strands causing a loss of translucency of the laminate.
   5. Fiberglass reinforced plastic: Fiberglass reinforced plastic or glass fiber and resin fabrication consisting of approximately 35 to 55 percent glass fiber reinforcement by weight for hand lay-up structural laminates and 55 to

70 percent glass for filament wound structural laminates, unless otherwise specified.

6. Mat: Fibrous material consisting of randomly oriented chopped or swirled filaments loosely held together with a binder.
7. Terminology of this Specification is in accordance with ASTM D883. Fabricators using this Specification are responsible for correct interpretation.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Shop Drawings and calculations:
   1. Submit general arrangement and fabrication drawings, calculations, and elements of the design.
   2. Include Submittal information which describes specifically how the equipment is to be built and details necessary to ascertain that products meet specified requirements. Provide in the form of drawings, standards, specifications, or other shop instructions, but may also be partially contained in quality control records. Submittal shall include, but not be limited to:
      a. Fabrication drawings.
      b. General arrangement drawings signed by an Engineer registered in the state where the Project is located, showing complete structural, fasteners, and erection procedures for a complete assembly.
      c. Quality control programs.
      d. Verification that the manufacturer has been engaged in fabrication of similar fiberglass reinforced plastic equipment for a minimum of 5 years.
      e. Statement of compliance with Contract design requirements, codes, and standards.
      f. Recommendation for each resin selection from the resin manufacturer.
      g. Type and amounts of fillers.
      h. Nominal corrosion liner description.
      i. Reinforcement types and glass content range for hand lay-up laminates.
      j. For filament wound laminates:
         1) Helix angle.
         2) Glass content range.
         3) Strand yield.
         4) Strand per inch in the winding band.
         5) Ply thickness.
         6) Amount of chop or unidirectional roving interspersed with winding, if any, and location within laminate.
      k. For other components:
         1) Construction type.
         2) Laminate thicknesses.
         3) Ply sequences.
         4) Glass content range.
      l. For secondary overlays (both interior and exterior):
         1) Laminate thicknesses.
         2) Ply sequences and widths.

m. Construction details: For assembly and other special configurations, including:
    1) Tank bottom/top attachments with knuckle configuration and overlays and thicknesses.
    2) Tank support and anchor lugs, including attachment details.
    3) Tank nozzles and installation, including cutout reinforcement, gusseting, and similar items.
    4) Tank lateral or other support fabrication details, including platform attachment clips and/or shoulders.
    5) Scrubber configuration and fabrication details of internal support system and other specialty items.
    6) Cover panel joints, anchorage detail, and details of doors and inspection ports and their attachment or incorporation within the cover.
n. Miscellaneous equipment required.
o. Test reports and certification of compliance with physical property requirements.
p. Color samples.
q. Manufacturer's installation instructions.
r. ASME RTP-1 certification.

C. Operation and maintenance data.

D. Warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: Fiberglass reinforced plastic manufacturer with experienced personnel, physical facilities, and management capacity sufficient to produce custom-made glass fiber and resin products of quality and size specified for a minimum of 5 years with satisfactory performance record.

B. Quality assurance plan: Fabricator shall be responsible for implementation of a comprehensive quality assurance plan. Quality assurance plan describes procedures with the following minimum requirements:
    1. Fabricator shall designate personnel to inspect equipment while in process and after completion to ensure compliance to every aspect of the Section and fabrication drawings.
        a. Inspection shall include, as a minimum, checks for visual defects, laminate thickness and sequence, glass content, Barcol hardness, dimensional tolerances, adherence to construction details, surface preparation, and environmental conditions.
        b. Fabricator's inspector shall complete a report of the findings, including method of measurement for each separate assembly.
    2. Prior to use of resins in fabrication, fabricator shall extract samples of resins and retain them for use by the Engineer. Sample size shall be 100 cubic centimeters minimum:
        a. Take 1 sample for each manufacturer's batch number if resin is received in the form it will be used.

b. If the fabricator alters the resin after receipt, such as through the addition of styrene, promoters, or other additives, take samples from each drum or portion thereof mixed with additives.
c. Fabricator shall provide documentation for each sample, including resin type, manufacturer, batch and lot number, drum number, complete listing of additives with amounts added, and description and manufacturer of each additive.

3. Fabricator shall inspect glass reinforcement prior to use in fabrication.
   a. Do not use glass that does not meet the manufacturer's acceptance standards.
   b. Do not use glass material that is wet or has been wet.
   c. For each type of glass and lot number used, fabricator shall record the manufacturer, product description, binder type, product code, production date, and lot number.
   d. For mat, woven roving, unidirectional roving, and cloth, also include in records actual measured weight per square yard of material.
4. Fabricator shall retain nozzle cutouts and other excess laminate, clearly marking each piece to identify its original location. These laminate samples become the property of the Owner.
5. For areas where valid laminate samples are not available, take sample plugs at the Engineer's request.
   a. Repair subsequent holes in a manner acceptable to the Engineer.
6. Fabricator shall verify glass content on available samples in accordance with ASTM D2584. Complete this test and submit the results complete for each major component where samples are available.
7. Prior to final shipment of the equipment, fabricator shall submit to the Engineer a complete quality control report, consisting of copies of records maintained for compliance with this Section.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design fiberglass reinforced plastic tanks, scrubbers, and other vessels following the procedures and methods, utilizing the equations and formulas, and incorporating safety factors and allowable design stresses and strains in accordance with ASME RTP-1.
   1. Base the design of duct and other fiberglass reinforced plastic equipment not covered by ASME RTP-1 on the engineering rationale, applicable formulas, and safety factors in accordance with ASME RTP-1.

B. Perform calculations necessary to ensure long-term, low risk service of the fiberglass reinforced plastic equipment with minimum reasonable maintenance requirements.
   1. Long-term, low risk service is defined as a service life of 20 years without major structural failure or leakage.
   2. Design shall ensure proper functioning of the equipment at the stated operating conditions.
   3. Design shall include as a minimum, engineering calculations, materials selection and documented physical and mechanical properties, and detailed drawings required for fabrication and assembly of the equipment.

C. Design in accordance with applicable national, regional, and local design and building codes.
   1. Wind and seismic forces shall be determined in accordance with the building code as specified in Section 01_41_00 - Regulatory Requirements.

D. Resistance to overturning shall not include the weight of the liquid contained in the equipment.

E. Consider the interaction of the installed system, including, but not limited to, thermal expansion of duct, tanks, and vessels and the effects of external loading from piping, fans, pumps, platforms, and other attached items.

F. Allow for the most severe combination of conditions which may include, but not be limited to, the following:
   1. Internal or external pressure.
   2. Static head of contents (working and test conditions).
   3. Mass of structure and contents.
   4. Design temperature, including upset conditions.
   5. Superimposed loads, such as seismic and wind forces.
   6. Bending moments due to eccentric loads.
   7. Localized loads acting at supports, lugs, and other attachments.
   8. Shock loads.
   9. Loads due to heating or cooling and thermal gradients.
   10. Loads applied during transport or erection.
   11. Loads imposed by personnel during erection and operations.
   12. Fatigue.

G. Use safety factors and allowable strains specified in ASME RTP-1 unless otherwise specified. Do not use safety factors and allowable strains less than the following:
   1. Allowable hoop and axial strain shall be 0.001 inch per inch for filament wound tanks.
   2. A safety factor of 10 for hand lay-up components in tension, flexure, or other loading conditions where elastic stability is not in question.
   3. A safety factor of 5 for external loading (vacuum) or local buckling due to seismic or wind loading.

H. Safety factors for upset conditions or infrequent loading situations may be less than the above values for the specific condition if acceptable to the Engineer.

I. There will typically be other aspects which should be considered. Identify and consider their effects, identify design limitations, and submit this information.

J. Provide test reports or other documentation for laminate properties used in the design.
   1. Laminates shall be similar in construction, layer sequence, resin type, and cure to those used to determine tested properties.
   2. Properties shall be adjusted to reflect reductions at operating temperatures.
   3. Test reports shall be provided for:
      a. Grating: Indicate grating strength and deflection.
      b. Physical properties of test cover panels.
      c. Tanks showing conformance with specified strength requirements.

K. Corrosion liner shall be a minimum of 100 mils in thickness, unless otherwise specified, and documentation shall be provided verifying veil type, liner thickness, and resin cure.
   1. Consider 50 mils of the corrosion liner as sacrificial and do not include it in determining structural wall thickness.
   2. Use structural wall thickness not less than 0.375 inches for tanks and vessels and 0.1875 inches for ductwork.
   3. Submit minimum structural thicknesses of other types of fiberglass reinforced plastic fabrications.

L. Laminate types may include hand layup, helical winding, and hoop/chop construction methods.
   1. In laminates with helix angles greater than 80 degrees and in hoop/chop laminates, orientate approximately 10 percent of the structural wall thickness at 0 degrees (longitudinal direction).
   2. Apply this reinforcement in at least 2 layers of weft unidirectional fabric and equally spaced within the structural wall.

M. For tanks and scrubbers; nozzles, determine manways and shell reinforcements according to the tables and formulas in ASME RTP-1.

N. Anchor tanks and vessels using lugs and a continuous filament wound band or an integral filament wound load ledge with external stainless steel anchor clips.
   1. Anchor clips shall be bolted to the concrete foundation; use non-shrink grout to level anchor clips.
   2. Design shall resolve the sum of the moments and the sum of the force equal to 0.

O. Design internal beams and support attachments using a maximum of 200 pounds per square inch shear stress for secondary bonds. Also apply this to design of external lugs required for ladders, platforms, and other attached items.

2.02 RESIN AND REINFORCEMENT MATERIALS

A. General physical properties: In accordance with ASTM C582, ASTM D3299, ASTM D4097, and ASME RTP-1, with verification of properties.
   1. Physical properties may include tensile, flexural, and compression modulus of elasticity and ultimate strengths, limiting strains, Poisson ratios, coefficients of expansion, and other directional properties as required for the design of the equipment.

B. Resin:
   1. Fabricate equipment using the corrosion-resistant resin(s) specified in the fiberglass reinforced plastic equipment specifications.
      a. Fabricator is required to obtain independent endorsement of each resin selection from the resin manufacturer.
      b. Unless otherwise specified, use the resin throughout laminates.

2. Type of catalyst recommended varies between resin manufacturers. Submit resin/catalyst before fabrication begins to verify compliance to the resin manufacturer's recommended procedures.
3. Employ no fillers, additives, or pigments in the resin.
    a. A thixotropic agent for viscosity control may be used in the proportion and type recommended by the resin manufacturer.
    b. Use no thixotropic agent in the corrosion liner or on surfaces to be in contact with the corrosive environment.
4. Make resin putty using the same resin as was used in the original fabrication and shall contain milled glass fibers.
    a. Use of silica flour, grinding dust, or other fillers is not allowed.
5. When specified, add antimony trioxide or antimony pentoxide to the resin in the amount necessary to achieve the required fire retardancy rating in the structural wall only. Follow the resin manufacturer's recommendations.
    a. Unless otherwise specified, the corrosion liner shall not contain this additive.

C. Reinforcement:
1. Show the type and sequence of reinforcements to be used on the fabrication drawings.
2. Use as commercial grade corrosion-resistant borosilicate glass fiber reinforcement, unless otherwise specified.
3. Use glass fiber reinforcing having a surface finish and binder that is specifically recommended by the glass manufacturer for the particular resin system to be used.
4. Use Type C (chemical grade) glass, 10 mils (0.01 inches) thickness, or polyester surfacing veil, such as Nexus surfacing veils.
5. Use Type E (electrical grade) glass, 1-1/2 ounces or 3/4 ounce per square foot, with nominal fiber length of 1.25, within 0.75 inches mat.
6. Continuous glass roving used in chopper guns for spray up shall be Type E chopper roving.
7. Woven roving shall be 24 ounces per square yard Type E glass and have a 5-by-4 plain weave.
8. Continuous roving used in filament wound structures shall be Type E glass winder roving with a yield of 200 yards or more per pound.
9. Use Type E glass unidirectional fabric. Weft unidirectional fabric shall be 15.7 ounces per square yard.
10. When specified, use Type ECR glass reinforcements supplied in similar fabric styles to those specified above.

2.03 FABRICATION

A. Molds:
1. Construct molds of a suitable material to produce a smooth and glossy corrosion liner surface on the fiberglass reinforced plastic equipment.
2. Covering of mandrels with cardboard must be accepted by the Engineer prior to start of fabrication.

B. Laminates:
1. Determine specified glass content in accordance with ASTM D2584.

2. Consider laminate thicknesses shown on the fabrication drawings as construction minimums.
    a. Verify that minimum thicknesses are obtained using the laminate sequences specified.
    b. When only total laminate thicknesses are specified or indicated on the Drawings, the minimum allowable structural laminate thickness shall be the total laminate thickness less the specified corrosion liner thickness.
3. Interruptions in laminating sequence shall follow the application of a ply of mat and be succeeded by a ply of mat.
4. Interruption shall not exceed 24 hours and the in-process surface must retain acetone sensitivity until laminating is resumed. Lack of compliance with these aspects or indication that contamination of the surface has occurred shall require that surface preparation be accomplished before resuming.
5. Chopped strand glass applied by chopper gun is allowed in lieu of mat layers in the structural laminates only.
    a. Chopper gun application of the corrosion liner is not allowed.
6. Coat non-mold surfaces with resin containing wax additive in the amount necessary to allow full cure of the surface. In the case of exterior surfaces, this wax coat shall also contain an ultraviolet stabilizer in the type and amount recommended by the resin manufacturer.
7. Exterior surface of equipment shall be resin-rich and reinforced with 1 layer C glass surfacing veil, unless otherwise specified.
8. When specified, the exterior coat shall be an opaque pigmented surface coat, applied only after the Engineer's inspection. Color shall be selected by the Engineer.

C. Corrosion liner laminates:
1. Inner surface of laminates shall be resin-rich and reinforced with surfacing veil of the type and number of layers as shown on the fabrication drawings.
2. Interior layer of the corrosion liner shall consist of 1-1/2 ounces per square foot mat in the number of layers specified on the fabrication drawings. An exotherm interruption is specifically prohibited within the corrosion liner.
3. Chopped glass applied by chopper gun is not allowed in the corrosion liner.
4. Plies of the inner surface and interior layer are to gel completely before proceeding with the structural laminates.
5. Completed corrosion liner as described above shall contain not less than 20 percent nor more than 30 percent glass by weight.
    a. Use no thixotropic material in the resin for the liner, nor in the fabrication of fiberglass reinforced plastic components intended for internal service.
    b. Completed liner shall be the minimum thickness specified or indicated on the Drawings.
6. Do not use a separately cured unreinforced gel coat.

D. Hand lay-up structural laminates:
1. Corrosion liner laminate shall be followed by hand lay-up structural laminates of varying reinforcement sequences as indicated on the fabrication drawings.
2. For hand lay-up structural laminates, reinforcement shall consist of mat and woven roving in the sequence specified on the fabrication drawings.
3. Woven roving shall have a ply of mat on each side. 2 adjacent plies of woven roving are not permitted.

4. Laminates containing primarily 1-1/2 ounces per square foot mat layers in conjunction with woven roving shall contain not less than 35 percent or more than 45 percent glass (by weight).
5. Laminates containing primarily 3/4 ounce per square foot mat layers in conjunction with woven roving are considered to be high strength laminates and shall contain not less than 45 percent or more than 55 percent glass by weight.

E. Filament wound structural laminates:
1. Corrosion liner laminate shall be followed by filament wound structural laminates as indicated on the fabrication drawings.
2. For filament wound structural laminates, reinforcement shall consist of continuous strand fiberglass roving applied with a minimum of interruptions until the specified minimum thickness is attained.
    a. This laminate shall contain 55 to 70 percent glass by weight as indicated on the fabrication drawings.
3. Each complete cycle of filament winding shall form a closed pattern of winding bands which completely covers the surface with 2 bi-directional layers.
    a. Each layer shall be a maximum of 1 roving in thickness.
    b. Uniformly space the filaments across the winding band without bunching or gaping.
4. Specify the helix angle of winding on the approved fabrication drawings, as measured from the centerline of revolution of the equipment shell.
5. Tolerance on helix angle is within 2 degrees, unless otherwise specified.
6. Fabrication drawings may require that layers of unidirectional roving be interspersed within the continuous filament winding.
7. Apply the unidirectional roving with the glass strand aligned in the axial direction to within 5 degrees.
8. If layers of mat or chopped glass are needed to ensure proper bonding of unidirectional roving, or within the filament winding to accommodate the fabricator’s manufacturing methods, consider the layers’ extra material that will result in a thickness greater than specified.
    a. Amount of filament winding and unidirectional roving specified must still be applied.

F. Joining laminates:
1. Fiberglass reinforced plastic joining laminates are subject to applicable requirements specified in other sections for laminates.
2. Reinforce fiberglass reinforced plastic joints with an overlay of glass reinforcement and resin which extends equally within 1/2 inch on each side of the joint. Use minimum thickness, ply sequence, and ply widths of fiberglass reinforced plastic joints as indicated on the fabrication drawings.
3. Restrain parts to be joined to prevent movement until completion and cure of the joint overlay.
4. Fit-up parts and verify that tolerances and assembly requirements are satisfied. Completely fill the void between component parts with resin putty, taking care not to extrude an excessive amount of putty into the interior.

G. Environment:
1. Fabrication process and materials at the point of fabrication are to be maintained within a range of 60 to 95 degrees Fahrenheit. This temperature

must also be at least 5 degrees greater than wet bulb temperature, as measured with a sling psychrometer.

2. Store materials in a dry area and within the temperature and humidity limits recommended by the manufacturers.

H. Flanges:

1. Make flanges by hand lay-up construction with nozzle neck and flange made integrally in 1 piece and fabricated in accordance with the dimensions indicated on the fabrication drawings. Extend layers of reinforcement in the nozzle neck and hub uninterrupted into the flange.
2. Build-up additional hub thickness using alternating layers of 1-1/2 ounces per square foot mat and 24 ounces per square yard woven roving.
3. Build-up additional thickness in the flange using “ring” cutouts of mat, evenly distributed throughout the flange thickness.
4. Press molded or filament wound flanges are not allowed.
5. Overall machine facing of the back of flanges is not permitted.
   a. To obtain proper seating, spotface bolt holes for SAE size washers.
   b. Resin coat bolt holes and other cut surfaces so that no fibers are exposed.
   c. Spotfacing shall not produce a flange thickness less than indicated in the fabrication drawings.
6. Bolt holes in flanges shall straddle principal centerlines of the equipment. Tolerance in bolt hole locations and in diameter of bolt circle shall be within 1/16 inch.
7. Depressions or projections in flange face shall be no greater than 1/32 inch.

I. Allowable visual defects:

1. Visual defects in areas of the equipment shall not exceed the maximum allowable levels specified in Table A, unless acceptable to the Engineer.
2. In accordance with ASTM D2563.
3. Presence of visual defects in excess of the allowable levels of Table A shall be grounds for rejection of the equipment. Listed quantities apply to small, localized areas and shall not be averaged over larger areas.

Table A - Maximum Allowable Levels Of Visual Defects

Condition/ Defect	Inner Surface(1)	Interior Mat Layers(2)	Structural Wall(3)	Exterior Surface(4)
Chip	None	None	None	
Crack	None	None	None	
Crazing	None	None	None	
Delamination	None	None	See Air Bubble	
Dry Spot	None	See Air Bubble	See Air Bubble	
Foreign Inclusion	None	Maximum Diameter 1/32”	See Air Bubble	
Fracture	None	None	None	None

Table A - Maximum Allowable Levels Of Visual Defects				
Condition/ Defect	**Inner Surface(1)**	**Interior Mat Layers(2)**	**Structural Wall(3)**	**Exterior Surface(4)**
Air Bubble/ Void	Less than 1/64" Ø unlimited. 1/64" to 1/16" Ø 2/sq. in. Maximum Diameter 1/16"	Less than 1/32" Ø unlimited. 1/32" to 1/8" Ø 5/sq. in. Maximum Diameter 1/8"	Less than 3/16" Ø unlimited. 3/16" to 1/4" Ø 2/sq. in. Maximum Diameter 1/4"	
Blister	See Air Bubble	See Air Bubble	See Air Bubble	
Burned	None	None	None	
Pit (Pinhole)	Less than 1/32" Ø 50/square feet. 1/32" to 1/16" Ø 10/square feet. Maximum Diameter 1/16" Maximum Depth 1/32"	N/A	N/A	
Resin Pocket	None	Maximum 1 square inch per occurrence	Maximum 1 square inch per occurrence	
Wrinkle	Allowable if laminate is glass reinforced. No sharp edges allowed.	Allowable if laminate is glass reinforced and full mat layer thickness and total thickness are maintained	Allowable if laminate is glass reinforced and full mat layer thickness and total thickness are maintained	
Scratch	None	N/A	N/A	
Fiber Prominence	None	Maximum 10 fibers visible per square inch	Maximum 20 fibers visible per square inch	

Notes:

Dimensions listed in this table refer to the largest dimension measured for defects.

(1) Inner surface: Interior process surface, thickness of surfacing veil(s), and interface between veils and mat layers. Includes surfacing veils on internal joints.
(2) Interior mat layers: Layers of mat following the inner surface, and interface between liner and structural wall. Includes mat layers on internal joints.
(3) Structural wall: Layers of filament winding or alternating layers of mat and woven roving following the corrosion liner, and layers of mat and woven roving in internal overlays.
(4) Exterior surface of the laminate and the thickness of the surfacing veil.

2.04 SOURCE QUALITY CONTROL

A. Inspection:
   1. Owner's inspection: Permit the Engineer access to the equipment during fabrication and upon completion for the purpose of verifying compliance with

the Contract Documents. Inspection is not intended to replace the fabricator's own quality control procedures.

2. In no respect does inspection of equipment by the Engineer relieve the fabricator of compliance with the Contract Documents.
   a. A final inspection will be performed by the Engineer.
3. Fabricator shall notify the Engineer at the completion of particular milestones during fabrication. Milestones are as follows:
   a. View tooling prior to fabrication.
   b. Beginning application of corrosion liner for each part, extraction of each part prior to beginning assembly.
   c. Upon completion of each separate assembly, the Engineer reserves the right to include additional milestones.
4. Allow the Engineer to photograph the equipment while in process and/or upon completion.
5. Engineer may use magnification or other special viewing or measurement devices during inspection.
6. Evidence of poor workmanship or lack of compliance with aspects of the Contract Documents will be grounds for rejection of the equipment.
7. Subsequent repair of rejected equipment may, at the Engineer's option, be undertaken in an attempt to bring the equipment to an acceptable state.
   a. Repair procedures must be accepted by the Engineer prior to implementation.

2.05 TESTING

A. Engineer may employ destructive testing, such as ultimate tensile or flexure strength tests or glass content ignition tests, on available samples or use other non-destructive test methods, such as acoustic emission or ultrasonic polygauge thickness measurement, on the completed equipment for verification of compliance with the Contract Documents.

B. Testing performed by the Engineer will be accomplished through use of applicable ASTM test methods when appropriate.

C. Hardness tests will be made for acceptance by the Engineer on the liner surface using the Barcol impressor, Model GYZJ 934 1, calibrated at 2 points in accordance with ASTM D2583.
   1. 10 readings will be taken in a localized area, deleting the 2 highest and 2 lowest, and averaging the remaining 6.
   2. Minimum acceptable Barcol hardness will be a reading of 30, unless otherwise specified.

D. An acetone sensitivity test will also be performed by the Engineer as an acceptance criteria. Evidence of a sticky or tacky surface following rubbing with an acetone-saturated cloth will be grounds for rejection of the equipment.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 07_11_00

DAMPPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Dampproofing.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1227 - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation meeting:
   1. As specified in Section 01_31_19 - Project Meetings.
   2. Prior to beginning Work, convene a meeting to review conditions, installation procedures, schedules, and coordination with other Work.
   3. Convene a minimum of 2 weeks prior to starting Work.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data.
   1. Manufacturer's data sheets on each product to be used, including:
      a. Preparation instructions and recommendations.
      b. Storage and handling requirements and recommendations.
      c. Installation methods.

C. Warranty:
   1. Sample warranty identifying the terms and conditions stated in the warranty article.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials in original, unopened containers in accordance with the manufacturer's printed instructions.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not apply bituminous dampproofing when temperatures are 40 degrees Fahrenheit or lower, or when rain is forecast for the 24 hours following application.

PART 2 PRODUCTS

2.01 MATERIALS

A. Dampproofing: ASTM D1227, Asbestos Free, Emulsified Asphalt Coatings:
   1. Manufacturers: One of the following or equal:
      a. Karnak Corp., Karnak 220 AF.
      b. W.R. Meadows, Inc., Sealmastic Type 2 Asphalt Emulsion Dampproofing.

B. Sealing mastic:
   1. Compatible with dampproofing and free of toxic solvents with thick mastic consistency and smooth and uniform in composition.
   2. As recommended by the dampproofing manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for application of products in accordance with the manufacturer's recommendations.

B. Verify that surfaces to receive dampproofing are clean, dry, reasonably smooth, free of dust, dirt, voids, cracks, or sharp projections.

3.02 APPLICATION

A. Completely cover surfaces to receive dampproofing with 2 coats:
   1. Applied by brush or spray.
   2. Apply dampproofing at the manufacturer's recommended rate of application or minimum 2 gallons per 100 square feet, whichever is greater.

B. Extend dampproofing to 6 inches above finish grade.

C. Apply each coat evenly so surfaces have uniform black appearance.

D. Apply second coat at right angles to first, allowing not less than 24 hours between coats.

E. Seal around items and services projecting through dampproofing surfaces in accordance with the manufacturer's recommendations.

F. Ensure sealed areas are moisture tight.

G. Backfill completely against dampproofing application within time recommended by the manufacturer.

END OF SECTION

SECTION 07_22_70

FALL PROTECTION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Roof tie-down system of fall restraint and fall arrest for worker safety.

B. Related Sections:
   1. Section 05_12_00 - Structural Steel.
   2. Section 07_54_23 - Thermoplastic Single Ply Roofing.

1.02 REFERENCES-

A. American Society for Testing and Materials (ASTM)

B. American National Standard Institute (ANSI)
   1. ANSI Z359.1-2007 - Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components
   2. ANSI Z359.6-2009 - Specifications and Design Requirements for Active Fall Protection Systems

C. Occupational Health And Safety Administration (OSHA)
   1. OSHA 1926.502 - Fall Prevention Systems Criteria and Practices

1.03 SYSTEM DESCRIPTION

A. General: Provide structural fall restraint and fall arrest system capable of withstanding loads and stresses within limits and under conditions specified in OSHA and other applicable safety codes. Provide fall protection system permanently attached to roof structure.

B. Design Requirements: Anchors and accessories comprising system of following types:
   1. Guardian CB Anchors, spaced as indicated by manufacturer, for safety snap connection by individual workers capable of withstanding a 5,000 pound load or safety factor of 2 meeting the requirements of OSHA 1926.502(d)(8).

C. Performance Requirements: System and components tested for the resistance of the following loads:
   1. Fall Restraint: 2 Users.
   2. Fall Arrest: 2 Users.
   3. Design fall protection anchors to resist a 5,000 pound load applied in any direction at maximum anchor height or provide engineered system designed meeting the requirements of OSHA 1926.502(d)(8).

1.04 SUBMITTALS

A. Product Data: For each type of device specified, including manufacturer's standard fabrication details and installation instructions.

B. Shop Drawings: Show layout, profiles, and anchorage details. Shop drawings and calculations to be stamped by a Professional Engineer registered in the State in which the project is located.

C. Maintenance Data: Written instructions for maintenance of fall prevention safety devices to be included in the operation and maintenance manual.

D. In-house Test Reports: Indicate anchor fabrication compliance with performance requirements.

E. Signage: Provide laminated sign showing system layout and usage notes, to be installed at roof access locations.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm having at least 10 years continuous experience in manufacturing fall safety equipment similar to systems specified and exhibiting records of successful in-service acceptability and performance. Firm must employ personnel dedicated to provide regularly scheduled Authorized and Competent Person Training courses as mandated by OSHA 1926 and 1910 for owner's authorized safety personnel.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of roof anchors that are similar to those indicated for this Project in material, design and extent.

C. OSHA Standards: Comply with Occupational Safety and Health Administration Standards for the Construction Industry 29 CFR § 1926.500 Subpart M (Fall Protection), and with applicable State Administrative Code safety standards for Fall Restraint and Fall Arrest.

D. Source Limitations: Obtain all roof anchors through one source from a single manufacturer.

E. Testing: Perform quality control tests for each system per manufacturer's requirements.

1.06 COORDINATION

A. Contractor to coordinate installation of structural deck to meet requirements of roof anchor manufacturer.
   1. Metal Deck: Minimum 18 gauge thickness, or provided with additional deck reinforcing per manufacturer's instructions.

B. Contractor to coordinate installation of structural deck reinforcements and anchorages to receive fall protection anchors.

C. Contractor to coordinate placement of roofing system, insulation and flashing to ensure water-tight integrity to roof.

1.07 WARRANTY

A. Provide manufacturer’s standard warranty to guarantee products will be free from defects for a period of 12 months. Warranty period shall become effective on date of substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. A. Provide fall protection system manufactured by Guardian Fall Protection Inc., 6305 South 231st Street Kent, WA, phone 800-466-6385, fax 800-670-7892.

2.02 MATERIALS

A. CB-12 anchor post: 2-1/2-inch schedule 80 pipe, galvanized steel.

B. CB anchor U-bar: 5/8-inch diameter U-bar, galvanized steel.

C. CB anchor base plate: galvanized steel.

2.03 MANUFACTURED ASSEMBLIES

A. Guardian CB Galvanized Roof Anchors.

2.04 FABRICATION

A. Fabricate work true to dimension, square, plumb, level, and free from distortions or defects detrimental to appearance and performance.

B. Prepare, treat and coat galvanized metal to comply with manufacturer's written instructions. Prepare galvanized metal by removing grease, dirt, oil, flux, and other foreign matter.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine framing and substrate and verify conditions comply with structural requirements for proper system performance.

B. Proceed with installation of roof anchors only after verifying conditions are satisfactory.

3.02 INSTALLATION

A. General: Installation of Anchors to be performed by contractor according to manufacturer’s instructions and recommendations.

3.03 FIELD QUALITY CONTROL

A. Testing: Test on site 100 percent of anchors relying upon chemical adhesive fasteners using load cell test apparatus in accordance with manufacturer's written recommendations.

3.04 ADJUSTMENT AND INSPECTION

A. Ensure all manufactured anchors have been installed in accordance with fall protection manufacturer’s engineering documentation and specifications.

B. Provide plan drawings with any deviations in anchor locations as installed.

END OF SECTION

SECTION 07_54_23

THERMOPLASTIC SINGLE-PLY ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. TPO Thermoplastic Single-Ply Roofing.

B. Membrane Flashings.

C. Metal Flashings.

D. Vapor Barriers.

E. Roof Insulation as noted in drawings. Provide tapered rigid insulation as required at the crickets for positive drainage. Contractor to review existing roof for any excessive puddling and build up those areas as required to achieve positive drainage required for new roofing membrane.

1.02 RELATED SECTIONS

A. Section 07_60_00 - Flashing and Sheet Metal.

1.03 REFERENCES

A. American Society of Civil Engineers (ASCE) - ASCE 7 - Minimum Design Loads for Buildings and Other Structures, Current Revision.

B. ASTM International (ASTM):
   1. ASTM C 208 - Standard Specification for Cellulosic Fiber Insulating Board.
   2. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   3. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
   4. ASTM D 1079 - Standard Terminology Relating to Roofing, Waterproofing, and Bituminous Materials.
   5. ASTM D 4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   6. ASTM D 6878 - Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing.
   7. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.

C. International Code Council (ICC):
   1. International Building Code (IBC).

D. National Roofing Contractors Association (NRCA) - Low Slope Roofing and Waterproofing Manual, Current Edition.

E. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - Architectural Sheet Metal Manual.

F. Underwriters Laboratories (UL):
   1. TGFU R1306 - "Roofing Systems and Materials Guide".
   2. UL-790 - Standard Test Method for Fire Tests of Roof Coverings.

G. ANSI/ASHRAE/IESNA Standard 9.1 (2007): Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.04 DESIGN CRITERIA

A. Wind Uplift Performance:
   1. Roof system is designed to withstand wind uplift forces as calculated using the current revision of ASCE-7-10.
   2. System warranty: Provide manufactures system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other causes.
      a. Warranty term: 20 years
      b. For repair and replacement including costs of both material and labor in warranty.
      c. Exceptions not permitted.
      d. Damage due to wind speeds up to 90 mph.

B. Fire Resistance Performance:
   1. Roof system will achieve a UL Class A rating when tested in accordance with UL-790.

C. Thermal Performance: Roof system will achieve a minimum R-38 value.

D. Drainage: Provide a roof system with positive drainage where all standing water dissipates within 48 hours after precipitation ends.

E. Building Codes:
   1. Roof system will meet the requirements of all federal, state and local code bodies having jurisdiction.

1.05 SUBMITTALS

A. Submit under provisions of Section 01_33_00 - Submittal Procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Detail Drawings:
   1. Submit approved plan, section, elevation or isometric drawings which detail the appropriate methods for all flashing conditions found on the project.
   2. Coordinate approved drawings with locations found on the Contract Drawings.

D. Selection Samples: For each finish product specified, two complete sets of chips representing manufacturer's full range of available colors, membranes, and thicknesses.

E. Verification Samples: For each finish product specified, two samples, minimum size 4 inches (100 mm) square representing actual product, color, and patterns.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of 20 years experience.

B. Installer Qualifications:
   1. All products listed in this section are to be installed by a single installer with a minimum of five years demonstrated experience in installing products of the same type and scope as specified.
   2. Installer must be capable of extending the Manufacturer's Labor and Materials guarantee.
   3. Installer must be capable of extending the Manufacturer's No Dollar Limit guarantee.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation, installation techniques and workmanship.
   1. Finish areas designated by Architect.
   2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
   3. Refinish mock-up area as required to produce acceptable work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local authorities having jurisdiction.

C. Material Safety Data Sheets (MSDS) must be on location at all times during the transportation, storage and application of materials.

D. When loading materials onto the roof, the Carlisle Authorized Roofing Applicator must comply with the requirements of the building owner to prevent overloading and possible disturbance to the building structure.

1.08 PROJECT CONDITIONS

A. Proceed with roofing work only when weather conditions are in compliance with the manufacturer's recommended limitations, and when conditions will permit the work to proceed in accordance with the manufacturer's requirements and recommendations.

B. Proceed with work so new roofing materials are not subject to construction traffic. When necessary, new roof sections shall be protected and inspected upon completion for possible damage.

C. Provide protection, such as 3/4 inch thick plywood, for all roof areas exposed to traffic during construction. Plywood must be smooth and free of fasteners and splinters.

D. The surface on which the insulation or roofing membrane is to be applied shall be clean, smooth, dry, and free of projections or contaminants that would prevent proper application of or be incompatible with the new installation, such as fins, sharp edges, foreign materials, oil and grease.

E. New roofing shall be complete and weather tight at the end of the work day.

F. Contaminants such as grease, fats and oils shall not be allowed to come in direct contact with the roofing membrane.

1.09 WARRANTY

A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's Total System warranty, outlining its terms, conditions, and exclusions from coverage.
   1. Duration: 20 Years.

B. When positioning membrane sheets, exercise care to locate all field splices away from low spots and out of drain sumps. All field splices should be shingled to prevent bucking of water.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Basis of Design: Carlisle SynTec , which is located at: P. O. Box 7000; Carlisle, PA 17013; Toll Free Tel: 800-4-SYNTEC; Tel: 717-245-7000; Fax: 717-245-7053; Email:http://admin.arcat.com/users.pl?action=UserEmail&company=Carlisle+SynTec+&coid=31255&rep=&fax=717-245-7053&message=RE:%20Spec%20Question%20(07545car):%20%20&mf=steve@harperwinn.com; Web:www.carlisle-syntec.com.
   2. Firestone Building Products.
   3. Johns Manville.

4. Thermoplastic Single Ply Roofing:
    a. GAF – EverGuard 60 mil TPO Membrane.
    b. GAF – EverGuard accessories.

B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

2.02 SCOPE/APPLICATION

A. Roof System: Provide a waterproof roof system, capable of withstanding uplift forces as specified in the Design Criteria article of this section.
    1. Membrane Attachment: Fully Adhered.

B. Base Flashing: Provide a waterproof, fully adhered base flashing system at all penetrations, plane transitions and terminations.

2.03 THERMOPLASTIC POLYOLEFIN (TPO) MEMBRANE

A. Sure-Weld Membrane:
    1. Color: White.
    2. Membrane Thickness: 60 mil nominal.
        a. Thickness over Scrim: 0.020 inches (0.508mm).
        b. Breaking Strength (ASTM D 751): 250 lbf/in (1.1 kN/m) minimum.
        c. Tear Resistance (ASTM D 751): 55 lbf/in (245 N/m) minimum.
        d. Elongation (ASTM D 751): 25 percent.
    3. Field Sheet Dimensions:
        a. Width: 10 feet (3.05 m) maximum.
        b. Length: 100 feet (30.5 m) maximum.

2.04 INSULATION

A. Polyisocyanurate InsulBase for base layer and top layer: Rigid board (sloped at crickets as shown on plans). Meeting ASTM C1289.
    1. Compressive Strength: 20 psi min
    2. Thickness: 3.3-inches per layer.

2.05 VAPOR BARRIERS

A. For Metal decks use VapAir Seal MD air and vapor Barrier:
    1. Thickness: .015-inches.
    2. Tensile strength: 250 psi.
    3. Permeability: 0.03 perms.

2.06 COVER BOARD

A. SecurShield HD: rigid roof insulation panel composed of a high-density, closed-cell polyisocyanurate foam core laminated to a premium-performance, coated glass fiber-mat facer:
    1. Compressive Strength: 100 psi.
    2. Board Thickness: 1/2 inch (13mm).

B. Water-resistant and silicone treated gypsum panel with embedded fiberglass facer on both sides, and pre-primed on one side. GP Gypsum Dens-Deck Prime, distributed by Carlisle.
   1. Board Thickness: 1/2 inch (13mm).

C. Moisture, mold and impact-resistant, non-structural fiber-reinforced gypsum panel made from 95 percent recycled materials. Securock Gypsum Fiber, distributed by Carlisle.
   1. Board Thickness: 1/2 inch (13mm).

2.07 FLASHING ACCESSORIES

A. Inside Corners: Pre-molded corner flashing for inside corners. 60 mil thickness. Color to match membrane. Special colors require custom fabrication process.

B. Outside Corners: Injection molded corner used for flashing outside corners. 60 mil thickness. Color to match membrane. Special colors require custom fabrication process.

C. TPO T-Joint Covers: Injection molded 60 mil thick TPO formed into a 4.5 inch (114mm) diameter circle used to seal step-offs at splice intersections. Color to match membrane. Special colors require custom fabrication process.

D. TPO Curb Wrap Corners: Pre-fabricated corner flashings made from 45 mil thick reinforced Sure-Weld membrane. 6 inch (152mm) wide base flange and a 12 inch (305mm) overall height. Sizes available to fit curbs up to 6 foot by 6 foot (1828 by 1828 mm) in size. Color to match membrane. Gray, tan and special colors require custom fabrication process.

E. Molded Pipe Seals: A pre-molded flashing and clamping ring used for pipe penetrations. Available for 0.75 inch to 8 inch (19 - 203.2mm) diameter pipes. Color to match membrane. Special colors not available.

F. Split Pipe Seals: Pre-fabricated flashing consisting of 45 mil thick reinforced Sure-Weld Membrane for pipes 1 inch to 6 inch (25.4 - 152.4mm) in diameter. A split (cut) and overlapped tab is incorporated to allow the pipe seal to be opened and wrapped around the pipe when it is not possible to pull a standard pipe flashing over a round penetration. Gray, tan and special colors require custom order fabrication. Custom sizes available on a special order basis.

G. TPO Square Tubing Wraps: Pre-fabricated flashings made of 45 mil thick reinforced Sure-Weld membrane for square tubing. A split (cut) and overlap tab are incorporated into these parts to allow the seals to be opened and wrapped around a square tubing penetration with an obstruction. Stock sizes include 3- inch, 4-inch, 5-inch and 6 inch (76, 102, 127, 152 mm) diameter square tubing. Gray, tan and special colors require custom order fabrication. Custom sizes available on a special order basis.

H. Pressure-Sensitive Cover Strip: A nominal 6 inch (152mm) wide by 40 mil thick non-reinforced TPO membrane laminated to nominal 35-mil thick cured synthetic rubber pressure-sensitive adhesive. Used in conjunction with TPO Primer to strip in flat metal flanges (i.e., drip edges or rows of fasteners and plates). Color to match membrane. Special colors not available.

I. TPO Pressure-Sensitive RUSS:
   1. 6 inch (152mm) RUSS: A nominal 6 inch (152mm) wide, 45 mil thick reinforced TPO membrane with nominal 3 inch (76mm) wide 35mil thick cured synthetic rubber pressure-sensitive adhesive laminated along one end. This product allows a continuous piece of membrane to be run up a parapet wall without fastener penetration through the field sheet at angle changes.

J. Sure-Weld Heat Weldable Walkway Rolls: Superior tear, puncture and weather resistance and designed to protect Sure-Weld membrane in those areas exposed to repetitive foot traffic or other hazards. Walkway material may be heat welded to Sure-Weld membrane using an automated heat welder or hand held heat welder. Walkway Rolls are 34 inches (864mm) wide by 50 feet (15.2 m) long and are nominal 180 mils thick. Color - White, gray and tan.

K. Non-Reinforced Flashing: Non-reinforced TPO flashing is a 60-mil thick non-reinforced TPO based membrane used for detail work where the use of pre-molded or pre-fabricated accessories are not feasible. Color - White, gray and tan. Special colors require lead time and 5,000 square foot minimum.

2.08 CLEANERS, PRIMERS, ADHESIVES AND SEALANTS

A. Cav-Grip III: CAV-GRIP III's Low-VOC, methylene chloride-free formula promotes tenacious adhesion and quick drying in a wide range of temperatures. Applied using a self-contained spray system that provides quick and even coverage, this system requires minimal cleanup or maintenance.

B. Sure-Weld Bonding Adhesive: A high-strength solvent-based contact adhesive used for bonding Sure-Weld membrane to various porous and non-porous substrates.
   1. Base: Synthetic Rubber.
   2. Color: Yellow.
   3. Solids: 20.0 percent.
   4. VOC: 670 grams/liter.

C. Cut Edge Sealant: A medium solids content, free flowing polymeric material designed for sealing cut edges (exposed fabric) of Sure-Weld reinforced membrane.

D. Water Cut-Off Mastic: A one-component, low viscosity, self wetting, Butyl blend mastic used as a compression sealing agent between membrane and applicable substrates.

E. TPO Primer: Solvent-based product designed to prepare TPO membrane for improved adhesion to TPO surfaces prior to the application of pressure-sensitive products and sealant pockets.

F. Universal Single-Ply Sealant: A 100 percent solids, solvent free, VOC free, one-part polyether sealant that provides a weather tight seal to a variety of building materials. It is used for general caulking such as above termination bars and metal counter flashings and at scupper details.. Available in white only.

G. Carlisle Weathered Membrane Cleaner: Clear, solvent-based cleaner used to loosen and remove contaminants from the surface of exposed membrane.

2.09 FASTENING COMPONENTS

A. InsulFast Fasteners: Threaded, #12 fastener with a #3 Phillips head used with 3 inch (76mm) diameter Insulation Plates. For insulation attachment into steel or wood decks.

B. Piranha Plates: A 2 3/8 inch (60mm) diameter metal barbed fastening plate used with Carlisle HP-X, CD-10 or HD 14-10 Fasteners for membrane securement. This plate can be used for insulation securement.

C. Insulation Fastening Plates: A nominal 3 inch (76mm) diameter metal plate used for insulation attachment in conjunction with the appropriate Carlisle Fastener.

2.10 EDGINGS AND TERMINATIONS

A. Sure-Seal Termination Bar: 1 inch (13 mm) wide, .098 inch (2.5mm) thick extruded aluminum bar pre-punched 6 inches (152 mm) on center with sealant ledge to support Lap Sealant.

B. Sure-Weld Coated Metal: 24-gauge (0.6 mm) galvanized steel sheet that is coated with a layer of .035-inch non-reinforced TPO flashing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Do not commence work until all other work trades have completed jobs that require them to traverse the deck on foot or with equipment.

D. A vapor retarder / temporary roof (Carlisle 725 TR Air & Vapor Barrier/Temporary Roof) may be applied to protect the inside of the structure prior to the roof system installation.

3.03 INSULATION/COVER BOARD PLACEMENT

A. Install insulation or membrane underlayment in multiple layers over the substrate with boards butted tightly together with no joints or gaps greater than 1/4 inch (6 mm). Stagger joints both horizontally and vertically if multiple layers are provided.

B. Secure insulation to the substrate with the required mechanical fasteners in accordance with the manufacturer's current application guidelines.

C. Do not install wet, damaged or warped insulation boards.

D. Stagger joints in one direction. Install insulation boards snug. Gaps between board joints shall not exceed 1/4 inch (6 mm). Fill all gaps in excess of 1/4 inch (6 mm) with same insulation material.

E. Wood nailers must be at least 3 1/2 inches (89 mm) wide or 1 inch (25 mm) wider than adjacent metal flange. Thickness must equal that of insulation but not less than 1 inch (25 mm) thickness.

F. Miter and fill the edges of the insulation boards at ridges, valleys and other changes in plane to prevent open joints or irregular surfaces. Avoid breaking or crushing of the insulation at the corners.

G. Do not install any more insulation than will be completely waterproofed each day.

3.04 INSULATION/COVER BOARD ATTACHMENT

A. Securely attach insulation to the roof deck for Adhered or Mechanically Fastened Roofing Systems. Attachment must have been successfully tested to meet or exceed the calculated uplift pressure required by the International Building Code (ASCE-7) or ANSI/SPRI WD-1.

B. Enhance the perimeter and corner areas in accordance with the International Building Code (ASCE-7) or ANSI/SPRI WD-1.

3.05 MEMBRANE PLACEMENT AND ATTACHMENT

A. Position Sure-Weld membrane over the acceptable substrate. Fold membrane sheet back lengthwise so half the underside of the membrane is exposed.

B. Apply Sure-Weld Bonding Adhesive or Cav-Grip III in accordance with the manufacturer's published instructions, to the exposed underside of the membrane and the corresponding substrate area. Do not apply Bonding Adhesive along the splice edge of the membrane to be hot air welded over the adjoining sheet. Allow the adhesive to dry until it is tacky but will not string or stick to a dry finger touch.
   1. Roll the coated membrane into the coated substrate while avoiding wrinkles. Brush down the bonded section of the membrane sheet immediately after rolling the membrane into the adhesive with a soft bristle push broom to achieve maximum contact.
   2. Fold back the unbonded half of the sheet lengthwise and repeat the bonding procedures.

C. Position adjoining sheets to allow a minimum overlap of 2 inches.

D. Hot-air weld the Sure-Weld membrane sheets using the Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer's hot air welding procedures. Carlisle recommends a test weld sample be made from a piece of scrap TPO to eliminate the need to remove a section from a completed seam. At all splice intersections, roll the seam with a silicone roller to ensure a continuous hot air welded seam.

E. Continue to install adjoining membrane sheets in the same manner, overlapping edges a minimum of 2 inches and complete the bonding procedures as stated previously.

3.06 SEAM WELDING

A. Hot-air weld membrane using an Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer's current guidelines. At all splice intersections, roll the seam with a silicone roller to ensure a continuous hot air welded seam.

B. Overlay all splice intersections with Sure-Weld T-Joint Cover.

C. Probe all seams once the hot air welds have thoroughly cooled (approximately 30 minutes).

D. Repair all seam deficiencies the same day they are discovered.

E. Apply Cut Edge Sealant on all cut edges of reinforced membrane (where the scrim reinforcement is exposed) after seam probing is complete. Cut Edge Sealant is not required on vertical splices.

3.07 FLASHING

A. Flashing of parapets, curbs, expansion joints and other parts of the roof must be performed using Sure-Weld reinforced membrane or prefabricated accessories. Sure-Weld non-reinforced membrane may be used for flashing pipe penetrations, Sealant Pockets, and scuppers, as well as inside and outside corners, when the use of pre-molded or prefabricated accessories is not feasible.

B. Follow manufacturer's typical flashing procedures for all wall, curb, and penetration flashing including metal edging/coping and roof drain applications.

C. Metal edge to have TPO Coated Metal

3.08 DAILY SEALS

A. On phased roofing, when the completion of flashings and terminations is not achieved by the end of the work day, a daily seal must be performed to temporarily close the membrane to prevent water infiltration.

B. Complete an acceptable membrane seal in accordance with the manufacturer's requirements.

3.09 CLEAN UP

A. Perform daily clean-up to collect all wrappings, empty containers, paper, and other debris from the project site. Upon completion, all debris must be disposed of in a legally acceptable manner.

B. Prior to the manufacturer's inspection for warranty, the applicator must perform a pre-inspection to review all work and to verify all flashing has been completed as well as the application of all caulking.

3.10 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 07_60_00

FLASHING AND SHEET METAL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.02 SUMMARY

A. This Section includes, but is not limited to the following: all PVDF (Kynar 500) polyvinylidene fluoride finish (to match existing color):
   1. Metal counter flashing and base flashing.
   2. Metal wall flashing.
   3. Miscellaneous sheet metal accessories and flashings, including reglets.
   4. Parapet Coping.

B. Roof accessory units of pre-manufactured, set-on type are specified in Division 7 Section "Roof Accessories."

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data, Flashing, Sheet Metal, and Accessories: Manufacturer's technical product data, installation instructions and general recommendations for each specified sheet material and fabricated product.

C. Samples of the following flashing, sheet metal, and accessory items:
   1. 8-inch-square samples of specified sheet materials to be exposed as finished surfaces.
   2. 12-inch-long samples of factory-fabricated products exposed as finished work. Provide complete with specified factory finish.

D. Shop drawings showing layout, profiles, methods of joining, and anchorages details, including major counterflashings, trim/fascia units, gutters, downspouts, scuppers, and expansion joint systems. Provide layouts at 1/4-inch scale and details at 3-inch scale.

1.04 PROJECT CONDITIONS

A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

PART 2 PRODUCTS

2.01 SHEET METAL FLASHING AND TRIM MATERIALS

A. Zinc-Coated Steel: Commercial quality with 0.20 percent copper, ASTM A 526 except ASTM A 527 for lock-forming, G90 hot-dip galvanized, 0.0359-inch thick (22 gauge) except as otherwise indicated.
   1. Finish: PVDF (Kynar 500) polyvinylidene fluoride finish (to match existing color).

B. Miscellaneous Materials and Accessories:

C. Fasteners: Same metal as flashing/sheet metal or other non- corrosive metal as recommended by sheet manufacturer. Match finish of exposed heads with material being fastened.

D. Bituminous Coating: SSPC - Paint 12, solvent-type bituminous mastic, nominally free of sulfur, compounded for 15-mil dry film thickness per coat.

E. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, non- drying, nonmigrating sealant.

F. Elastomeric Sealant: Generic type recommended by manufacturer of metal and fabricator of components being sealed and complying with requirements for joint sealants as specified in Division 7 Section "Joint Sealers."

G. Epoxy Seam Sealer: 2-part noncorrosive metal seam cementing compound, recommended by metal manufacturer for exterior/interior nonmoving joints including riveted joints.

H. Adhesives: Type recommended by flashing sheet manufacturer for waterproof/weather-resistant seaming and adhesive application of flashing sheet.

I. Paper Slip Sheet: 5-lb. rosin-sized building paper.

J. Polyethylene Underlayment: Minimum 6-mil carbonated polyethylene film resistant to decay when tested in accordance with ASTM E 154.

K. Reglets: Metal or plastic units of type and profile indicated, compatible with flashing indicated, noncorrosive.

L. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size and gage required for performance.

M. Elastic Flashing Filler: Closed-cell polyethylene or other soft closed-cell material recommended by elastic flashing manufacturer as filler under flashing loops to ensure movement with minimum stress on flashing sheet.

N. Roofing Cement: ASTM D 2822, asphaltic.

2.02 FABRICATED UNITS

A. General Metal Fabrication: Shop-fabricate work to greatest extent possible. Comply with details shown and with applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry practices. Fabricate for waterproof and weather-resistant performance, with expansion provisions for running work, sufficient to permanently prevent leakage, damage, or deterioration of the work. Form work to fit substrates. Comply with material manufacturer instructions and recommendations for forming material. Form exposed sheet metal work without excessive oil-canning, buckling, and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.

B. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. For metal other than aluminum, tin edges to be seamed, form seams, and solder. Form aluminum seams with epoxy seam sealer; rivet joints for additional strength where required.

C. Expansion Provisions: Where lapped or bayonet-type expansion provisions in work cannot be used or would not be sufficiently water/weatherproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

D. Sealant Joints: Where movable, non-expansion type joints are indicated or required for proper performance of work, form metal to provide for proper installation of elastomeric sealant, in compliance with SMACNA standards.

E. Separations: Provide for separation of metal from non-compatible metal or corrosive substrates by coating concealed surfaces at locations of contact, with bituminous coating or other permanent separation as recommended by manufacturer/fabricator.

PART 3 EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. General: Except as otherwise indicated, comply with manufacturer's installation instructions and recommendations and with SMACNA "Architectural Sheet Metal Manual." Anchor units of work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.

B. Bed flanges of work in a thick coat of bituminous roofing cement where required for waterproof performance.

C. Install reglets to receive counterflashing in manner and by methods indicated. Where shown in concrete, furnish reglets to trades of concrete work for installation as work of Division 3 sections.

D. Install counterflashing in reglets, either by snap-in seal arrangement or by welding in place for anchorage and filling reglet with mastic or elastomeric sealant, as indicated and depending on degree of sealant exposure.

E. Nail flanges of expansion joint units to curb nailers, at maximum spacing of 6 inches o.c. Fabricate seams at joints between units with minimum 3-inch overlap, to form a continuous, waterproof system.

3.02 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Protection: Advise Contractor of required procedures for surveillance and protection of flashings and sheet metal work during construction to ensure that work will be without damage or deterioration other than natural weathering at time of Substantial Completion.

END OF SECTION

SECTION 07_84_00

FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: The requirements for providing firestopping.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E814 - Standard Test Methods for Fire Tests of Penetration Firestops Systems.

B. International Code Council (ICC).

C. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Product data: Submit manufacturer's data and installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Firestopping:
   1. Intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures over 250 degrees Fahrenheit.
   2. Product shall be UL classified and have ICC approved fire resistance rating up to 3 hours in accordance with ASTM E814.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fill and seal holes or voids in fire rated floors and walls including pipes penetrating between buildings with acceptable firestopping material in accordance with manufacturer's instructions:
   1. Penetrations shall be free of dirt and debris.
   2. Dam penetrations, if required, with an acceptable material.

B. Apply firestopping material to the penetration using a caulking gun, putty knife, or other normal trade tools:
   1. Provide minimum 1/2-inch caulk or putty for 2-hour fire rating with metal pipe.
   2. Provide minimum 1-inch caulk or putty for 3-hour rating with metal or insulated metal pipe.

C. Normal curing time is 7 days; however, seal shall be immediately functional, providing cold smoke, water, and fire seal.

D. Remove damming materials if necessary after cure.

3.02 CLEANING

A. Clean surrounding areas after installation in compliance with manufacturer's instructions.

END OF SECTION

SECTION 07_92_00

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Acrylic-Latex sealant.
   2. Precast concrete joint sealant.
   3. Silicone sealant.
   4. Synthetic rubber sealing compound.
   5. Synthetic sponge rubber filler.
   6. Related materials.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. M198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. ASTM International (ASTM):
   1. C920 - Standard Specification for Elastomeric Joint Sealants.
   2. C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   3. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
   4. C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
   5. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   6. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

1.03 SUBMITTALS

A. Product data.

B. Samples, include color selections.

C. Manufacturer's Installation Instructions.

D. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.05 PROJECT/SITE CONDITIONS

A. Environmental requirements: Do not apply sealant on wet or frosty surfaces or when surface temperature is higher than 100 degrees Fahrenheit or lower than recommended by the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

B. Code date packages. Do not use material older than manufacturer’s published shelf life. Store materials at temperatures lower than 80 degrees Fahrenheit. Condition materials in accordance with manufacturer’s instructions prior to installation.

1.07 SEQUENCING AND SCHEDULING

A. Caulk joints prior to painting.

1.08 WARRANTY

A. Warrant to correct defective products for minimum 1 year in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 SEALANTS

A. General:
   1. Provide colors matching materials being sealed.
   2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
   3. Nonsagging sealant for vertical and overhead horizontal joints.
   4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
   5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
   6. Sealant backer rod and/or compressible filler made from closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
      a. Control joint depth.

b. Break bond of sealant at bottom of joint.
c. Provide proper shape of sealant bead.
d. Serve as expansion joint filler.

2.02 ACRYLIC-LATEX SEALANT

A. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound, colors as selected by Engineer from manufacturer's standard options:
1. Manufacturers: One of the following or equal:
a. Tremco, Tremflex 834.
b. Pecora Corp., Number AC-20.
c. Sonneborn, Sonolac.

2.03 PRECAST CONCRETE JOINT SEALANT

A. Preformed, cold-applied, ready-to-use, flexible joint sealant in accordance with ASTM C990 and AASHTO M 198:
1. Manufacturers: One of the following or equal.
a. Henry Corp., Ram-Nek.
b. Concrete Sealants Division, ConSeal.

2.04 SILICONE SEALANT

A. ASTM C920, Type S, Grade NS, Class 25, single component silicone sealant:
1. Manufacturers: One of the following or equal:
a. Tremco, Proglaze.
b. Pecora Corp., Number 864.
c. Dow Corning, Number 795.
d. General Electric, Number 1200 Series.

2.05 SYNTHETIC RUBBER SEALING COMPOUND

A. Manufacturer: One of the following or equal:
1. Sika Corporation, Sikaflex 2c NS or SL.
2. Pacific Polymers, Elastothane 227R.

B. Material: In accordance with ASTM C920 Type M, Grade P (pourable), Class 25 and Type M, Grade NS (non-sag), Class 25; multi-part polyurethane; able to cure at room temperature to firm, highly resilient polymer; able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition; with the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:
1. Base: Polyurethane rubber.
2. Application time: Minimum 2 hours.
3. Cure time: Maximum 3 days.
4. Tack free time: Maximum 24 hours.
5. Ultimate hardness: Non-sag 25, Pourable/SL 40, within 5 Shore A.
6. Tensile strength: Non-sag 95 pounds per square inch minimum and self-leveling minimum 170 pounds per square inch when tested in accordance with ASTM D412.

7. Ultimate elongation: Minimum 340 percent when tested in accordance with ASTM D412.
8. Tear resistance: Non-sag 45 pounds per inch minimum and self-leveling minimum 85 pounds per inch when tested in accordance with ASTM D624, Die C.
9. Service temperature range: Minus 25 degrees to 158 degrees Fahrenheit.

C. Color: Gray to match concrete, unless indicated on the Drawings.

2.06 SYNTHETIC SPONGE RUBBER FILLER

A. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod. In accordance with ASTM C1330, Type C:
1. Manufacturers: The following or equal:
a. Presstite, No. 750.3 Ropax Rod Stock.

B. Characteristics:
1. Suitable for application intended.
2. Strength: As necessary for supporting sealing compound during application.
3. Resiliency: Resistance to environmental conditions of installation.
4. Bonding: No bonding to the sealing compound.
5. Structure: Cellular, prevents absorption of water.
6. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.
7. Size: Minimum 25 percent greater than nominal joint width.

2.07 RELATED MATERIALS

A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.

B. Joint cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.

C. Bond breaker tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify acceptability of joint dimensions, physical, and environmental conditions.

B. Verify that surfaces are dry, clean, and free of dirt, grease, curing compound, and other residue which might interfere with adhesion of sealants.

3.02 PREPARATION

A. Allow concrete to cure thoroughly before caulking.

B. Synthetic sponge rubber filler:
   1. Prepare surfaces designated to receive filler in accordance with manufacturer's installation instructions.
   2. Do not stretch filler beyond its normal length during installation.

C. Caulking:
   1. Verify that surfaces are dry, clean, and free of dirt, grease, curing compounds, and other residue that might interfere with adhesion of sealant.
   2. Concrete, masonry, wood, and steel surfaces: Clean and prime in accordance with manufacturer's instructions prior to caulking.

D. Synthetic rubber sealing compound:
   1. Ensure surfaces to which synthetic rubber must bond are dry and free of dust, dirt, and other foreign residue.
   2. Heavy sandblasted caulking groove to sound surface, and prime with manufacturer's recommended primer for particular surface.

E. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but neither more than 5/8 inches deep nor less than 3/8 inches deep.

F. For normal moving building joints sealed with elastomeric sealants not subject to traffic, fill joints to depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.

G. For joints sealed with acrylic-latex sealants, fill joints to depth in range of 75 percent to 125 percent of joint width.

H. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

I. Prepare surfaces and install synthetic sponge rubber filler in accordance with manufacturer's recommendations.

J. Do not stretch filler beyond normal length during installation.

K. Apply bond breaker when recommended by joint sealer manufacturer.

3.03 INSTALLATION

A. Synthetic sponge rubber filler: Install filler in accordance with manufacturer's installation instructions.

B. Caulking, joints, and sealing:
   1. Construct expansion, contraction, and construction joints as indicated on the Drawings.
   2. Install pipe and conduit in structures as indicated on the Drawings.
   3. Caulk doors, windows, louvers, and other items installed in or over concrete openings inside and out.

4. Use synthetic rubber sealing compound for caulking where indicated on the Drawings or as specified, except for masonry construction and where specified otherwise.
5. Complete caulking prior to painting.
6. Verify that concrete is thoroughly cured prior to caulking.
7. When filler compressible material is used, use untreated type.
8. Apply caulking with pneumatic caulking gun.
9. Use nozzles of proper shape and size for application intended.
10. Maintain continuous bond between caulking and sides of joint to eliminate gaps, bubbles, or voids and fill joint in continuous operation without layering of compound.
11. Employ experienced applicators to caulk joints and seams in neat workmanlike manner.
12. To hasten curing of compound when used on wide joints subject to movement, apply heat with infrared lamps or other convenient means.
13. Apply synthetic rubber sealing compound with pneumatic caulking tool or other acceptable method.

3.04 CLEANING

A. Clean surfaces adjacent to sealant as work progresses.

B. Remove excess uncured sealant by soaking and scrubbing with sealant cleaning solvent.

C. Remove excess cured sealant by sanding with Number 80 grit sandpaper.

D. Leave finished work in neat, clean condition.

3.05 SCHEDULE

A. Acrylic latex:
1. Use where indicated on the Drawings.
2. Interior joints with movement less than 7.5 percent and not subject to wet conditions.

B. Silicone:
1. Use where indicated on the Drawings.
2. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.
3. Door threshold bedding.
4. Moist or wet locations, including joints around plumbing fixtures.
5. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.
6. Plenum joints.

C. Synthetic rubber sealing compound, non-sag Type II:
1. Use where indicated on the Drawings.
2. Water-bearing and earth-bearing concrete structures.
3. Joints in masonry, concrete vertical surfaces, and metal-faced panels in vertical surfaces.

4. Joints between sheet metal flashing and trim.
5. Joints between sheet metal flashing and trim, and vertical wall surfaces.
6. Small voids between materials requiring filling for weathertight performance in vertical surfaces.
7. Perimeters of frames of doors, windows, louvers, and other openings where bonding is critical to airtight performance.
8. Expansion and control joints in masonry vertical surfaces.

D. Synthetic rubber sealing compound, self-leveling Type I:
1. Use where indicated on the Drawings.
2. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.
3. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.
4. Pavement joints.
5. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

3.06 FIELD QUALITY CONTROL

A. Adhesion testing:
1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
a. Water bearing structures: 1 test per every 1,000 LF of joint sealed.
b. Exterior precast concrete wall panels: 1 test per every 2,000 LF of joint sealed.
c. Chemical containment areas: 1 test per every 1,000 LF of joint sealed.
d. Building expansion joints: 1 test per every 500 LF of joint sealed.
e. All other type of joints except butt glazing joints: 1 test per every 3,000 LF of joint sealed.
f. Manufacturer's authorized factory representative provide written recommendations for remedial measures on failing tests.

END OF SECTION

SECTION 08_11_13

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel Fire Resistive Rated and Non-Fire Resistive Rated:
   1. Doors.
   2. Door frames.
   3. Combination door frames and window frames with mullions, muntins, and transom bars.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A250.6 - Hardware on Steel Doors (Reinforcement Application).
   2. A250.8 - Recommended Specification for Standard Steel Doors and Frames.

B. ASTM International (ASTM):
   1. A653 - Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
   3. A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy With Improved Formability, Solution Hardened, and Bake Hardenable.
   4. A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy With Improved Formability, and Ultra-High Strength.
   5. E413 - Classification for Rating Sound Insulation.

C. National Association of Architectural Metal Manufacturers (NAAMM)/Hollow Metal Manufacturers Association (HMMA):
   1. HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames.

D. Steel Door Institute (SDI):
   1. SDI-111 - Recommended Details for Standard Steel Doors, Frame, Accessories and Related Components.
   2. SDI-117 - Manufacturing Tolerances Standard Steel Doors and Frames.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings: Show the following with references to the Engineer's door marks and hardware groups:
   1. Location of door and frame types.
   2. Details of fabrication, including core construction, glass lights, louvers, weatherstripping, and factory finish for each door.
   3. Cutouts and reinforcements for hardware.
   4. Methods of installation and anchorage to adjacent construction.

C. Manufacturer's instructions: Submit manufacturer's installation instructions.

D. Pre-Submittal Conference:
   1. Conduct conference in compliance with requirements in Section 01_31_19 - Project Meetings with attendance by representatives of Supplier, Installer.
   2. Contractor to review proper methods and procedures for installing hollow metal doors and frames**.**

1.04 QUALITY ASSURANCE

A. Testing agency qualifications: Approved by ultimate enforcing authority for the Project; regularly engaged in inspection of materials and workmanship at factory.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Before delivery, identify type and size of each door and frame in such a way that markings will not damage finish.

B. Preassemble doorframes in shop and deliver to Project site with spreader bar at sill or tie them in pairs to form box.

C. Protect doors and frames with resilient packaging sealed with heat shrunk plastic. Break seal on-site to permit ventilation.

D. Protect doors and frames during shipment and storage to prevent warping, bending, and corrosion.

1.06 SEQUENCING AND SCHEDULING

A. Ensure timely delivery of reviewed hardware schedule and hardware templates such that no delay occurs in the work of the Contract.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet steel: ASTM A1008, commercial quality, level, cold rolled steel, or ASTM A1011, hot rolled, pickled and oil rolled steel. Galvanize by hot-dip process with zinc-coating in accordance with ASTM A924 or with ASTM A653 and the coating designation A60 or G60.

B. Clips, bolts, screws, and rivets: sized as recommended by manufacturer.

C. Primer: Rust- inhibitive epoxy primer compatible with high-solids epoxy finish coating system as specified in Section 09_96_01 - High-Performance Coatings.

D. Touch-up materials: Primer as recommended by manufacturer.

E. Door hardware: As specified in Section 08_71_00 - Door Hardware.

F. Grout: As specified in Section 04_22_00 - Concrete Unit Masonry.

2.02 DOOR AND FRAME TYPES

A. Exterior doors: ANSI 250.8, Grade III, Model 3, or NAAMM HMMA 810 Type A and NAAMM HMMA 861, flush steel rib-stiffened, minimum 16-gauge face sheets.

B. Exterior frames: ANSI 250.8 or NAAMM HMMA 861, fully welded frames HMMA 861, except minimum 14-gauge sizes and shapes as indicated on the Drawings.

2.03 FABRICATION OF FRAMES

A. Galvanize all frames installed in exterior openings.

B. Frames: Sheet steel, integral type, welded continuous to full depth of frames with minimum 5/8-inch deep stops, unless otherwise indicated on the Drawings.

C. Hardware reinforcements: Fabricate according to SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Jamb Anchors: As required for adjacent wall construction, minimum 3 per jamb, unless otherwise indicated on the Drawings.

E. Floor anchors: Fixed type, except where adjustable anchors are indicated on the Drawings, 1 per jamb, with minimum 2 holes for anchorage. Where floor fill occurs, terminate bottom of frames at indicated finished floor level and support by adjustable extension clips resting on and anchored to structural slabs.

F. Anchors at masonry: Adjustable strap and stirrup, minimum 16-gauge corrugated or perforated steel at maximum of 30 inches on center and extending minimum 8 inches into masonry.

G. Anchors at previously placed concrete: Countersink machine screws through the frame into expansion devices spaced at maximum 30 inches on center.

H. Masonry angle stiffeners: Factory welded into heads of frames for installation in openings more than 48 inches wide.

I. Mullions, muntins, and transom bars: Minimum 18-gauge, tubular sheet steel matching, and butt-welded to head and jamb members.

J. Removable stops: Fasten at approximately 12 to 16 inches on center.

2.04 FABRICATION OF DOORS

A. Galvanize all doors installed in exterior openings.

B. Reinforce face sheets with steel rib stiffeners, spaced at maximum 6 inches apart, and securely attached to face sheets by spot welds at maximum 5 inches on center.

C. Fill voids between face sheets and stiffeners with fiberglass insulation having a minimum density of 0.8 pounds per cubic foot.

D. Edges: Full weld without visible joints. Bevel striking edge 1/8 inch in 2 inches.

E. Door cores:
   1. Stiffeners: Vertical steel ribs formed from minimum 22-gauge plain sheet steel, spaced at maximum 6 inches apart and securely attached to face sheets by spot welds at maximum 5 inches on center.
   2. Core fillers: Insulation, minimum 0.60 pound density noncombustible type, installed in spaces between stiffeners for full height of door; labeled door core material shall conform to requirements of labeling authority.

F. Tops and bottoms of doors: Close with continuous recess steel channel of minimum 16-gauge, extending full width of door and spot welded to both faces.

G. Tops and bottoms of exterior doors: Flush closing channels welded to make tops and bottoms waterproof with weep holes for escape of moisture.

H. Hardware reinforcements: Fabricate according to SDI A250.6 with reinforcing plates from same material as door face sheets.

I. Astragals:
   1. Install on active leaf of double doors in accordance with UL listing requirements for fire resistive ratings as indicated on the Drawings, and for exterior pairs of doors.
   2. Do not install on doors swinging in pairs with rating of 90 minutes or less in means of egress where both leaves are required to provide building code required exiting widths.
   3. Do not provide astragal cutouts for hardware operations.

2.05 ACCESSORIES

A. Mullions and transom bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout guards: Formed from same material as frames, not less than 0.016 inches thick.

2.06 FINISHING

A. Thoroughly clean surfaces of oil, grease, and other impurities; touch-up abraded galvanizing; and chemically etch.

B. Fill irregularities and sand smooth finish surface. Apply 1 coat of manufacturer's standard rust inhibitive baked-on primer.

C. Finish painting: High solids epoxy polyurethane system:
   1. Exterior doors : As specified in Section 09_96_01 - High-Performance Coatings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine reviewed hardware schedules and verify proper coordination of hardware and doors and frames.

B. Examine opening locations and verify the following:
   1. Correctness of dimensions, backing, or support conditions.
   2. Absence of defects that would adversely affect frame or door installation.

3.02 INSTALLATION

A. Install doors and frames in accordance with approved shop drawings and manufacturer's instructions.

B. Frames:
   1. Set accurately in position, plumb, align, and attach securely to structure.
   2. Set in place before construction of adjacent masonry or framed walls.
   3. Anchor frames to previously placed concrete.
   4. Set frames before removing spreader bars.
   5. Fully grout frames in masonry as the Work progresses.
   6. Grout frames at concrete through keyways provided at head and jambs.

C. Doors:
   1. Install at correct openings, ensure smooth swing and proper closure with frame.

D. Door hardware:
   1. Install in accordance with Section 08_71_00 - Door Hardware.
   2. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

E. Separate or isolate dissimilar metals with neoprene gaskets, sleeves, and washers, or with coatings acceptable to the Engineer.

3.03 TOLERANCES

A. Manufacturing and installation tolerances: As indicated on the Drawings or in conformance to SDI 117 as minimum.

3.04 ADJUSTING AND CLEANING

A. Prime coat touch-up: Immediately after installation, sand smooth and touch-up rust areas, and other areas where primer has been damaged, with prime touch-up paint.

B. Make adjustments as required for correct, proper, and free function and smooth operation without binding of hardware or doors and frames.

C. Protect doors and frames from damage to surface or profile.

END OF SECTION

SECTION 08_11_17

ALUMINUM FLUSH DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Aluminum flush doors with aluminum frames.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tube.
   3. D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
   4. D1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
   5. D2126 - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
   6. D6670- Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products
   7. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   8. E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   9. E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
   10. E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
   11. F2927 - Standard Test Method for Door Systems Subject to Airblast Loadings.

B. National Fenestration Rating Council (NFRC):
   1. 102-2010 - Thermal Performance Test.

1.03 SUBMITTALS

A. In accordance with Section 01_33_00 - Submittal Procedures.

B. Product data: Submit manufacturer's product data, including description of materials, components, fabrication, finishes, and installation.

C. Shop drawings: Submit manufacturer's shop drawings, including elevations, sections, and details, indicating dimensions, tolerances, materials, fabrication, doors, panels, framing, hardware schedule, finish, options, and accessories.

D. Samples:
   1. Door: Submit manufacturer's sample of door showing face sheets, core, framing, finish, and accessories.
   2. Color: Submit manufacturer's samples of standard colors of doors and frames.

E. Test reports: Submit test reports from qualified independent testing agency indicating doors comply with specified performance requirements.

F. Manufacturer's project references: Submit list of successfully completed projects including project name and location, name of Engineer and type and quantity of doors manufactured.

G. Maintenance manual: Submit manufacturer's maintenance and cleaning instructions for doors, including maintenance and operating instructions for hardware.

H. Warranty: Submit manufacturer's standard warranty.

I. Pre-Submittal Conference:
   1. Conduct conference in compliance with requirements in Section 01_31_19 - Project Meetings with attendance by representatives of Supplier, Installer, and Contractor.
      a. Contractor to review proper methods and procedures for installing hollow metal doors and frames.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying opening door mark and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.

C. Handling: Protect materials and finish from damage during handling and installation.

1.05 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

B. Special warranty:

   1. Warrant doors, frames, and factory hardware against failure in materials and workmanship, including excessive deflection, faulty operation, defects in hardware installation, and deterioration of finish or construction in excess of normal weathering.
   2. Duration: 10 years warranty starting on date of shipment. In addition, a limited lifetime (while the door is in its specified application in its original installation) warranty covering: Failure of corner joinery, core deterioration, delamination or bubbling of door skin.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following or equal:
   1. Special-Lite, Inc.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. General: Provide door assemblies that have been designed and fabricated to comply with specified performance requirements, as demonstrated by testing manufacturer's corresponding standard systems.

B. Air infiltration:
   1. For a single door, test specimen shall be tested in accordance with ASTM E283 at pressure differential of 6.27 pounds per square foot.
   2. Door shall not exceed 0.18 cubic feet per minute per square foot.

C. Uniform structural load: For a single door, test specimen shall be tested in accordance with ASTM E330, plus or minus 240 pounds per square foot.

D. Blast test in accordance with ASTM F2927, 6.91 pounds per square inch, 41 pounds per square inch - meters per second: Minimal hazard.

E. Water penetration resistance in accordance with ASTM E331: Pass.

F. Thermal transmission, exterior doors, U-value, NFRC 102-2010: Maximum of 0.47 BTU/hr x sf x degrees Fahrenheit.

G. Indoor air quality testing in accordance ASTM D6670: GREENGUARD Environmental Institute Certified including GREENGUARD for Children and Schools Certification.

H. Compressive strength, foam core, nominal value, ASTM D1621: 79.9 pounds per square inch.

I. Compressive Modulus, Foam Core, Nominal Value, ASTM D1621: 370 pounds per square inch.

J. Tensile adhesion, foam core, nominal value, ASTM D 1623: 45.3 pounds per square inch.

K. Thermal and humid aging, nominal value, 158 degrees Fahrenheit and 100 percent humidity for 14 Days, ASTM D2126: Minus 5.14 percent volume change.

2.03 ALUMINUM FLUSH DOORS

A. Model: SL-16 aluminum flush doors with aluminum frames.

B. Door opening size: As indicated on the Drawings.

C. Construction:
   1. Door thickness: 1-3/4 inches.
   2. Stiles and rails: Aluminum extrusions made from prime-equivalent billet that is produced from 100 percent reprocessed 6063-T6 alloy recovered from industrial processes, minimum of 2-5/16-inch depth.
   3. Corners: Mitered.
   4. Provide joinery of 3/8-inch diameter full-width tie rods through extruded splines top and bottom integral to standard tubular shaped stiles and rails reinforced to accept hardware as specified.
   5. Securing internal door extrusions:
      a. 3/16-inch angle blocks and locking hex nuts for joinery.
      b. Welds, glue, or other methods are not acceptable.
   6. Furnish extruded stiles and rails with integral reglets to accept face sheets. Lock face sheets into place to permit flush appearance.
   7. Rail caps or other face sheet capture methods are not acceptable.
   8. Extrude top and bottom rail legs for interlocking continuous weather bar.
   9. Meeting stiles:
      a. Pile brush weather seals.
      b. Extrude meeting stile to include integral pocket to accept pile brush weather seals.
   10. Bottom of door: Install bottom weather bar with nylon brush weatherstripping into extruded interlocking edge of bottom rail.
   11. Glue: Use of glue to bond sheet to core or extrusions is not acceptable.

D. Face sheet:
   1. Material: 0.125-inch thick aluminum.
   2. Texture: Smooth.

E. Core:
   1. Material: Poured-in-place polyurethane foam.
   2. Density: Minimum of 5 pounds per cubic foot.
   3. R-Value: Minimum of 9.
   4. ASTM E84: Class A.

F. Cutouts:
   1. Manufacture doors with cutouts for required vision lites, louvers, and panels.
   2. Factory install vision lites, louvers, and panels.

G. Hardware:
   1. Pre-machine doors in accordance with templates from specified hardware manufacturers and hardware schedule.
   2. Factory installed hardware.

2.04 MATERIALS

A. Aluminum members:
   1. Aluminum extrusions made from prime-equivalent billet that is produced from 100 percent reprocessed 6063-T6 alloy recovered from industrial processes: ASTM B221.

2. Sheet and plate: ASTM B 209.
3. Alloy and temper: As required by manufacturer for strength, corrosion resistance, application of required finish, and control of color.

B. Components: Door and frame components from same manufacturer.

C. Fasteners:
1. Material: Aluminum, 18-8 stainless steel, or other non-corrosive metal.
2. Compatibility: Compatible with items to be fastened.
3. Exposed fasteners: Screws with finish matching items to be fastened.

2.05 FABRICATION

A. Sizes and profiles: Required sizes for door and frame units, and profile requirements shall be as indicated on the Drawings.

B. Coordination of fabrication: Field measure before fabrication and show recorded measurements on shop drawings.

C. Assembly:
1. Complete cutting, fitting, forming, drilling, and grinding of metal before assembly.
2. Remove burrs from cut edges.

D. Welding: Welding of doors or frames is not acceptable.

E. Fit:
1. Maintain continuity of line and accurate relation of planes and angles.
2. Secure attachments and support at mechanical joints with hairline fit at contacting members.

2.06 ARCHITECTURAL PANELS

A. Model: SL-36 Aluminum Architectural Panels.
1. Size: As indicated on the Drawings.
2. Thickness: 1-3/4-inches
3. Finish: Dark Bronze.
4. Texture: Smooth.
5. Insulated panels:
a. Core: Foam polyurethane, minimum 5 pounds per cubic foot density.
b. Face sheets:
1) Material: 0.125-inch thick aluminum.
6. Rigid backing: 1/8-inch thick hardboard.
7. 1/4-Inch panels:
a. Core: 1/8-inch thick hardboard.
b. Face sheets: 0.062-inch thick aluminum.

2.07 ALUMINUM DOOR FRAMING SYSTEMS

A. Tubular framing:
1. Size and type: As indicated on the Drawings.

2. Materials: Aluminum extrusions made from prime-equivalent billet that is produced from 100 percent reprocessed 6063-T6 alloy recovered from industrial processes, 1/8-inch minimum wall thickness.
3. Applied door stops:
    a. 0.625-inch high, with screws and weatherstripping.
    b. Doorstop shall incorporate pressure gasketing for weathering seal.
    c. Counterpunch fastener holes in door stop to preserve full metal thickness under fastener head.
4. Frame members:
    a. Box type with 4 enclosed sides.
    b. Open-back framing is not acceptable.
5. Caulking: Caulk joints before assembling frame members.
6. Joints:
    a. Secure joints with fasteners.
    b. Provide hairline butt joint appearance.
7. Field fabrication: Field fabrication of framing using stick material is not acceptable.
8. Applied stops:
    a. For side, transom, and borrowed lites and panels.
    b. Applied stops shall incorporate pressure gasketing for weathering seal.
    c. Reinforce with solid bar stock fill for frame hardware attachments.
9. Hardware:
    a. Pre-machine and reinforce frame members for hardware in accordance with manufacturer's standards and hardware schedule.
    b. Factory installed hardware.
10. Anchors:
    a. Anchors appropriate for wall conditions to anchor framing to wall materials.
    b. Doorjamb and header mounting holes shall be spaced no more than 24 inches apart.
    c. Secure head and sill members of transom, side lites, and similar conditions.
11. Side lites:
    a. Factory pre-assemble side lites to greatest extent possible.
    b. Mark frame assemblies according to location.

2.08 HARDWARE

A. Pre-machine doors in accordance with templates from specified hardware manufacturers and hardware schedule.

B. Factory installed hardware.

C. Hardware schedule: As specified in Section 08_71_00 - Door Hardware.

D. Finish: As specified in Section 08_71_00 - Door Hardware.

2.09 VISION LITES

A. Factory glazing: 1-inch glass insulating units.

B. Lites in exterior doors: Allow for thermal expansion.

C. Rectangular lites:
   1. Size: narrow lite as indicated on the Drawings.
   2. Factory glazed with screw-applied aluminum stops anodized to match perimeter door rails.

2.10 ALUMINUM FINISHES

A. Anodized finish: Class I finish, 0.7 mils thick:
   1. Dark bronze, AA-M10C12C22A44, Class I, 0.7 mils thick.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive doors. Notify Engineer of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Ensure openings to receive frames are plumb, level, square, and in tolerance.

3.03 INSTALLATION

A. Install doors in accordance with manufacturer's instructions.

B. Install doors plumb, level, square, true to line, and without warp or rack.

C. Anchor frames securely in place.

D. Separate aluminum from other metal surfaces with bituminous coatings or other means approved by Engineer.

E. Set thresholds in bed of mastic and backseal.

F. Install exterior doors to be weathertight in closed position.

G. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Engineer.

H. Remove and replace damaged components that cannot be successfully repaired as determined by Engineer.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for installation of doors.

3.05 ADJUSTING

A. Adjust doors, hinges, and locksets for smooth operation without binding.

3.06 CLEANING

A. Clean doors promptly after installation in accordance with manufacturer's instructions.

B. Do not use harsh cleaning materials or methods that would damage finish.

3.07 PROTECTION

A. Protect installed doors to ensure that, except for normal weathering, doors will be without damage or deterioration at time of substantial completion.

END OF SECTION

SECTION 08_31_14

FLOOR ACCESS DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Non-fire-rated floor access doors.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. Occupational Safety and Health Administration (OSHA):
   1. 29 CFR 1910-Occupational Safety and Health Standards.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings that include the following:
   1. Floor access door installation recommendations.
   2. Locations of floor access doors.
   3. Door size and configuration.
   4. Live load capacity.
   5. Materials of construction and finishes provided.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Identify type and size of each floor access door in way not to damage finish prior to delivery.

B. Deliver products only after proper facilities are available.

C. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of use.

D. Handle carefully to prevent damage and store on clean concrete surface or raised platform in safe, dry area.
   1. Do not dump onto ground.

E. Protect floor access doors during shipment and storage to prevent warping, bending, and corrosion.

1.05 WARRANTY

A. Provide manufacturer’s warranty against defects in material and workmanship for a period of 5 years.

1.06 MAINTENANCE

A. Deliver 2 keys for each cylinder lock to Owner.

PART 2 PRODUCTS

2.01 LIGHT-DUTY FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Floor Doors Model K or KD (double leaf).
   2. Babcock Davis Associates, Inc., Model BFDNA-SAL or BFDNA-DAL (double leaf).

B. Style: Single leaf or double leaf as indicated on the Drawings, aluminum, capable of withstanding minimum live load of 150 pounds per square foot, and designed to open to 90 degrees and lock automatically in that position.

C. Door leaf: 1/4-inch aluminum diamond-pattern plate reinforced with aluminum stiffeners as required for specified live load.

D. Frame: 1/4-inch extruded aluminum with built-in neoprene cushion and with strap anchors bolted to exterior.

E. Hardware:
   1. Hinges: Cast steel hinges bolted to underside door leaf that pivot on torsion bars that counterbalance door for ease of operation.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.
   4. Operating mechanism: Automatic hold-open arm.

2.02 MEDIUM-DUTY FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Model J-AL or JD-AL (double leaf).
   2. Nystrom, Model FDDPA_X_SFL or FDDPA_X_DFL (double leaf).

B. Style: Single leaf or double leaf as indicated on the Drawings, capable of withstanding minimum live load of 300 pounds per square foot, channel frame, with drainage couplings.

C. Material: Unless otherwise specified elsewhere, aluminum.

D. Door leaf: Minimum 1/4-inch, diamond-pattern plate reinforced with stiffeners as required to meet specified live load.

E. Frame: 1/4-inch channel with anchor flange around perimeter.

F. Hardware:
   1. Hinges: Each leaf equipped with a minimum of 2, Type 316 stainless steel.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.

4. Operating mechanism: Spring operators designed for ease of operation and automatic hold-open arm with release handle.
5. Drainage assembly: Provide 1-1/2-inch drainage coupling located in corner of the channel frame.

2.03 FALL PROTECTION GRATING SYSTEM

A. Furnish and install on vault access doors, where scheduled, fall protection grating system.
   1. Door manufacturer shall install the grating system when the door is fabricated or field installed (by others) on existing doors already in use.
   2. If field installation is necessary grating system shall be installed per the manufacturer’s instructions.

B. Performance characteristics:
   1. Grating panel(s) shall be high visibility safety yellow in color.
   2. Grating panel(s) shall lock automatically in the full open position.
   3. Grating system shall have a 25 year warranty.
   4. Grating panel(s) shall have a provision for locking to prevent unauthorized opening.

C. Grating: Panels shall be aluminum with a powder coat paint finish and designed to meet OSHA 29 CFR 1910 requirements for fall protection.

D. Hold open feature: A Type 316 stainless steel hold open device shall be provided to lock the cover in the fully open 90 degree position.

E. Hardware: All hardware shall be Type 316 stainless steel.

F. Fall protection grating system schedule:
   1. Area 440 - 2 feet by 2 feet floor access doors.

2.04 FINISHES

A. Floor access door finishes:
   1. Aluminum: Manufacturer's standard mill finish.
   2. Aluminum in contact with dissimilar metals and concrete: Manufacturer's standard bituminous coating.
   3. Steel: Manufacturer's standard red oxide primer.

B. Hardware finishes:
   1. Provide optional Type 316 stainless steel hardware throughout, including parts of the latch and lifting mechanism assemblies, hold-open arms, and all brackets, hinges, pins, and fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine construction to receive floor access door and verify correctness of dimensions and other supporting or adjoining conditions.

3.02 PREPARATION

A. Coordinate details with other work supporting, adjoining, or requiring floor access doors.

B. Verify dimensions and profiles for each opening.

C. Verify that location will serve portion of work to which access is required.
   1. Where proposed functional location conflicts with other work, notify the Engineer before installation.

D. Apply coating to aluminum surfaces that will be in contact with dissimilar metals or concrete when there is none.

3.03 INSTALLATION

A. Install floor access doors in accordance with manufacturer's instructions.

B. Ensure correct types and adequate sizes at proper locations.

C. Securely attach frames to supporting work and ensure doors, frames, and hardware operate smoothly and are free from warp, twist, and distortion.

3.04 ADJUSTING

A. Adjust doors, frames, and hardware to operate smoothly, freely, and properly without binding.

3.05 CLEANING

A. Thoroughly clean surfaces of grease, oil, or other impurities; touch up abraded prime coat where applicable.

END OF SECTION

SECTION 08_71_00

DOOR HARDWARE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Door hardware.

1.02 REFERENCES

A. Builders Hardware Manufacturers Association (BHMA):
   1. A156.1 - Butts and Hinges.156.2 - Bored and Preassembled Locks and Latches.
   2. A156.3 - Exit Devices.
   3. A156.4 - Door Controls.
   4. A156.13 - Mortise Locks and Latches.
   5. A156.14 - Sliding and Folding Door Hardware.
   6. A156.16 - Auxiliary Hardware.
   7. A156.18 - Materials and Finishes.
   8. A156.23 - Electromagnetic Locks.
   9. A156.26 - Continuous Hinges.
   10. A156.31 - Electric Strikes and Frame Mounted Actuators.
   11. A156.36 - Auxiliary Locks.

B. International Building Code (ICC):
   1. A117.1 - Accessible and Usable Buildings and Facilities.

1.03 SUBMITTALS

A. Product data:
   1. Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
   2. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

B. Hardware schedule:
   1. Include references to Engineer's hardware group number, door type designations, locations, other pertinent data, and manufacturer names or suitable abbreviation opposite items scheduled.
   2. Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
      a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

b. Organization:
    1) Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
    2) Organize door hardware sets in same order as in the Door Hardware Sets at the end of this Section.
    3) Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
c. Content: Include the following information:
    1) Type, style, function, size, label, hand, and finish of each door hardware item.
    2) Manufacturer of each item.
    3) Fastenings and other pertinent information.
    4) Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    5) Explanation of abbreviations, symbols, and codes contained in schedule.
    6) Mounting locations for door hardware.
    7) Door and frame sizes and materials.
    8) Warranty information for each product.
d. Submittal Sequence:
    1) Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule.
    2) Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Keying schedule: Include list giving key code and numbers of doors which can be opened by each key.

D. Samples: Include for each different type and manufacturer for review of finish.

E. Construction key distribution list: Submit upon Owner's request.

F. Templates:
    1. Furnish hardware templates to fabricators of doors, frames, and other work to be factory-prepared for hardware.
    2. Check shop drawings of other work to confirm that adequate hardware backing is available.

G. Project record documents: Include corrected hardware schedule.

H. Operating and Maintenance Manuals:
    1. Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation.
    2. As specified in Section 01_78_24 - Operation and Maintenance Manuals.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver hardware where directed in unopened packages with items packed separately, complete and ready for installation with necessary fittings, trim, fasteners, and accessories.

B. Provide packages bearing the manufacturers' labels with each item or group of items identified according to the accepted hardware schedule.

1.05 QUALITY ASSURANCE

A. Certified products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

B. Installer qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door hardware supplier qualifications:
   1. Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project.
   2. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity.
   3. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

D. Source limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
   1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. Pre-submittal conference:
   1. Conduct coordination conference in compliance with requirements in Section 01_31_19 - Project Meetings with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
   2. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products.
   3. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors.

Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
4. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
5. Review sequence of operation narratives for each unique access controlled opening.
6. Review and finalize construction schedule and verify availability of materials.
7. Review the required inspecting, testing, commissioning, and demonstration procedures.

1.06 MAINTENANCE

A. Require lockset manufacturers to deliver permanent removable cylinder cores and keys and minimum 2 extractor keys to Owner directly.

1.07 SCHEDULING AND SEQUENCING

A. Upon receipt of accepted hardware schedule, coordinate accepted hardware schedule, templates, reinforcing units, and template instructions to door and frame sections.

B. Restrict distribution of construction keys to superintendents and foremen. Maintain record of persons who have received keys on construction distribution list.

1.08 MAINTENANCE TOOLS AND INSTRUCTIONS

A. Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.09 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.
1. Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
a. Structural failures including excessive deflection, cracking, or breakage.
b. Faulty operation of the hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Electrical component defects and failures within the systems operation.

B. Special warranty:
1. Duration for electromechanical door hardware: 2 years.
2. Duration for standard duty cylindrical (bored) locks and latches: 5 years.
3. Duration for exit hardware: 5 years.
4. Duration for mortise locks and latches: 10 years.
5. Duration for manual overhead door closer bodies: 10 years.
6. Duration for heavy duty floor closers: 10 years.

PART 2 PRODUCTS

2.01 GENERAL

A. Door hardware includes, but is not necessarily limited to, the following:
   1. Mechanical door hardware.
   2. Electromechanical door hardware.
   3. Automatic operators.
   4. Cylinders.

2.02 FASTENERS

A. Types:
   1. To concrete, marble, or masonry: Machine screws and flush shells.
   2. To wood: Wood screws.
   3. On gypsum board or plaster: Screws of sufficient length to provide solid connection to framing or backing behind gypsum board or plaster.
   4. To mineral and hollow core doors: Hex bolts.
   5. Of exit devices to doors: Thru-bolts, unless otherwise specified.

B. Screws exposed: Phillips-head type, full-threaded screws, not combination type.

C. Sizes: Suitable for heavy use.

D. Finish: Stainless steel, unless otherwise required to match material and hardware finish.

2.03 HANGING DEVICES

A. Hinges: BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
   1. Quantity: Provide the following hinge quantity:
      a. 2 Hinges: For doors with heights up to 60 inches.
      b. 3 Hinges: For doors with heights 61 to 90 inches.
      c. 4 Hinges: For doors with heights 91 to 120 inches.
      d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
      e. Hinge size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
         1) Widths up to 3 feet 0 inches: 4-1/2 inches standard or heavy weight as specified.
         2) Sizes from 3 feet 1inch to 4 feet 0 inched: 5inches standard or heavy weight as specified.
      f. Hinge weight and base material: Unless otherwise indicated, provide the following:
         1) Exterior doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
         2) Interior doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

g. Hinge options: Comply with the following:
   1) Non-removable pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
h. Manufacturers: One of the following or equal:
   1) Hager Companies (HA).
   2) Ives (IV).
   3) McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).

2.04 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
   1. Flat-lip strikes: For locks with 3-piece antifriction latch-bolts, as recommended by manufacturer.
   2. Extra-long-lip strikes: For locks used on frames with applied wood casing trim.
   3. Aluminum-frame strike box: Provide manufacturer's special strike box fabricated for aluminum framing.
   4. Double-lipped strikes:
      a. For locks at double acting doors.
      b. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:
   1. Strikes for Mortise Locks and Latches: BHMA A156.13.
   2. Strikes for Bored Locks and Latches: BHMA A156.2.
   3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
   4. Dustproof Strikes: BHMA A156.16.

2.05 CONSTRUCTION KEYING

A. Type: Removable core system that is compatible and matches Owner’s standard lock system.

2.06 CLOSERS

A. Manufacturers:
   1. Features:
      a. Heavy-duty.
      b. Non-handed and non-sized.
      c. Adjustable spring power from size 1 through 4.
      d. Hold open feature where specified.
      e. Manufacturer's special rust inhibitive epoxy primer on every part.
   2. One of the following or equal:
      a. Sargent, 351 Series.
      b. LCN, Super Smoothee Model 4041 Series.
      c. Norton Door Controls, Multi-Size Door Closers Model 7500BF Series.

B. Type: Full rack and pinion type with steel spring and non-gumming, non-freezing hydraulic fluid.

C. Controls: Separate set for regulating sweep speed, latch speed, backcheck and backcheck positioning, or where schedules, spring power.

D. Sizes: As recommended by accepted manufacturer.

E. Covers: Plastic, capable of being spray painted to match adjacent hardware finishes, unless otherwise specified.

F. Narrow frame provisions: Drop plates.

G. Effort to operate: As follows:
   1. Exterior: Maximum 8-1/2 pounds.

H. Adjust closers in accordance with manufacturer's directions for size of door.

2.07 EXIT DEVICES

A. Lever design:
   1. Manufacturers: The following or equal:
      a. Von Duprin, Lever Model 06.

B. Rim device, non-fire resistive rated:
   1. Manufacturers: One of the following or equal:
      a. Von Duprin Inc., Model Series 98.
      b. Sargent Essex Ind., Model Series 8800.

C. Material: As scheduled.

D. Corrosive environment provisions: Zinc dichromate coated internal parts.

2.08 MISCELLANEOUS DOOR HARDWARE

A. Mechanical holders: Foot-operated plunger with instant release by touch of toe and integral spring to keep constant shoe pressure against floor; brass.
   1. Manufacturers: The following or equal:
      a. Glynn-Johnson.

B. Flush bolts and surface bolts:
   1. BHMA A156.3 and A156.16, Grade 1, certified.
      a. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately 6 feet from the floor.
      b. Furnish dust proof strikes for bottom bolts.
      c. Surface bolts to be minimum 8 inches in length, UL listed for labeled fire doors, and UL listed for windstorm components where applicable.
      d. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
      e. Manufacturers: One of the following or equal:
         1) Ives (IV).
         2) Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
         3) Trimco (TC).

C. Architectural seals:
   1. General:
      a. Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets.
      b. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated.
      c. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
   2. Replaceable seal strips:
      a. Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
   3. Manufacturers: One of the following or equal:
      a. National Guard Products (NG).
      b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
      c. Zero (ZE).

D. Thresholds:
   1. As scheduled, extruded aluminum, maximum 1/2-inch high, maximum slope of 1 foot in 2 feet.
   2. Manufacturers: One of the following or equal:
      a. National Guard Products Inc.
      b. Pemko Mfg. Co.

E. Dustproof strike:
   1. As scheduled.
   2. Manufacturers: One of the following or equal:
      a. Ives.
      b. Trimco.

F. Door bottoms:
   1. As scheduled, extruded aluminum with vinyl insert, surface mounted, length equal to door width minus 2 inches, automatic, recessed in bottom of door.
   2. Manufacturers: One of the following or equal:
      a. Pemko.
      b. Reese.

G. Astragals:
   1. As specified in Sections 08_11_13 - Hollow Metal Doors and Frames.

2.09 FINISHES

A. Brass and bronze: BHMA A156.18 626 (US26D), satin chrome.

B. Steel: BHMA A156.18 652 (US26D), satin chrome.

C. Stainless steel: BHMA A156.18 630 (US32D), satin stainless steel.

D. Aluminum: BHMA A156.18 628 (US28).

E. Plastic closer covers: Spray paint to match typical door hardware finish.

F. Metal closer covers: Plate covers to match typical door hardware finish.

G. Electromagnetic hold open devices: Manufacturer's standard brushed zinc finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect doors and door frames for damage or defects and examine hardware for compatibility with receiving conditions and suitable to intended use.

B. Verify that required wall backing has been installed.

3.02 INSTALLATION

A. Install finish hardware in accordance with manufacturer's templates and instructions.
   1. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
   2. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: Hanging devices; locking devices; closing devices; and seals.

B. Accurately and properly fit hardware.

C. Securely fasten fixed parts for smooth, trouble-free, non-binding operation.

D. Fit faces of mortise parts snug and flush.

E. Ensure that operating parts move freely and smoothly without binding, sticking, or excessive clearance.

F. Mounting heights:
   1. Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
   2. Standard steel doors and frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   3. Wood doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
   4. Where indicated to comply with accessibility requirements, in accordance with ICC A117.1 "Accessibility Guidelines for Buildings and Facilities."
   5. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

G. Retrofitting:
   1. Install door hardware to comply with manufacturer's published templates and written instructions.

2. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Section 09_96_01 - High-Performance Coatings.
3. Do not install surface-mounted items until finishes have been completed on substrates involved.

H. Protection:
1. Protect door hardware from damage or marring of finish during construction, use strippable coatings, removable tapes, or other acceptable means.
2. Ensure door hardware displays no evidence of finish paint after final building cleanup.

I. Latch guard and dead bolts: Install so that bolts automatically engage in keeper, whether activated by closer or by manual pressure.

J. Closers:
1. Mount on opposite sides of corridors or vestibules, except at exterior doors.
2. Mount for 180-degree swing wherever possible.
3. Mount with drop plates at narrow top rail doors.
4. Adjust to operate noiselessly and evenly.
5. Have closer manufacturer regulate closers prior to final acceptance of project.

K. Gasketing: Mount to provide complete contact between door and frame, finished floor, or both; and weathertight enclosure.

L. Thresholds:
1. Install immediately before inspection for Substantial Completion or protect from heavy traffic damage during construction.
2. Cope to fit door frame profile and drill to suit required flush bolts and panic bolts.
3. Unless indicated on the Drawings to be set in grout, set in double bead of sealant, tightly fit at jambs, and make waterproof.
4. Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Section 07_90_00 - Joint Sealants.
5. Fasten to concrete slab with 5/16-inch stainless steel flat head countersunk machine screws and concrete anchors at 8-inch centers.

M. Storage:
1. Provide a secure lock up for hardware delivered to the project but not yet installed.
2. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.03 DOOR HARDWARE SETS

A. They are a guideline only and should not be considered a detailed hardware schedule.

B. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

C. Quantities listed are for each pair of doors, or for each single door.

D. The Supplier is responsible for handing and sizing all products.

E. Where multiple options for a piece of hardware are given in a single line item, the Supplier shall provide the appropriate application for the opening.

F. Provide a list of Manufacturer's Abbreviations.

3.04 CONSTRUCTION KEYING

A. Insert construction cores in cylinders of exterior doors, and doors requiring security and access for workman, unless otherwise directed by the Engineer.

3.05 ADJUSTING

A. Examine hardware in place for complete and proper installation. Lubricate bearing surfaces for proper function.

B. Replace, rework or otherwise correct defective door hardware, including incorrect hand or function.

3.06 CLEANING

A. Remove protective materials and devices and thoroughly clean exposed surfaces of hardware.

B. Check for surface damage prior to final cleaning for acceptance of project.

3.07 HARDWARE SCHEDULE

A. While the Hardware Schedule is intended to cover all doors and other moveable parts of the building and establish a type and standard of quality, it shall be the specific duty and responsibility of the finish hardware supplier to examine the Drawings and Specifications and furnish proper hardware for all openings.

3.08 HARDWARE GROUPS

A. Sludge Storage Building (Area 42):
   1. HW-1: Single Doors:
      a. 3 EA Hinge BB1191 4 1/2 X 4 1/2 US26D HA.
      b. 1 EA Exit Device 9875L X 996L-M US26D VO.
      c. 1 EA Closer 7500 SN-134 689 NO.
      d. 1 SET Weatherstripping 303AS PE.
      e. 1 EA Door Bottom 216AV PE.
      f. 1 EA Threshold 170A PE.
      g. 1 EA Raindrip 346C PE.
   2. HW-2: Double Door:
      a. 3 EA Hinge BB1191 4 1/2 X 4 1/2 US26D HA.
      b. 1 EA Exit Device 9875L X 996L-M US26D VO.
      c. 1 SET Manual Flush Bolt FB458 P630 Ives.
      d. 1 EA Dust Proof Strike DP2626 Ives.
      e. 1 EA Astragal 357 C600 PE.
      f. 1 EA Closer 7500 SN-134689 NO.
      g. 1 SET Weatherstripping 303AS PE.
      h. 1 EA Door Bottom 216AV PE.
      i. 1 EA Threshold 170A PE.
      j. 1 EA Raindrip 346C PE.
   3. HW-3: Double Door: Door swings 180 degrees with hold open:
      a. 3 EA Hinge BB1191 4 1/2 X 4 1/2 US26D HA.
      b. 1 EA Exit Device 9875L X 996L-M US26D VO.
      c. 1 SET Manual Flush Bolt FB458 P630 Ives.
      d. 1 EA Dust Proof Strike DP2626 Ives.
      e. 1 EA Astragal 357 C600 PE.
      f. 1 EA Closer P7500H 689 NO.
      g. 1 SET Weatherstripping 303AS PE.
      h. 1 EA Door Bottom 216AV PE.
      i. 1 EA Threshold 170A PE.
      j. 1 EA Raindrip 346C PE.
      k. 1 EA Floor Door Stop with manual hold-open Ives.

END OF SECTION

SECTION 08_80_00

GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Glass and glazing.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Z97.1 - Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.

B. ASTM International (ASTM):
   1. C1036 - Standard Specification for Flat Glass.
   2. C1048 - Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass.
   3. E773 - Standard Test Method for Accelerated Weathering of Sealed Insulating Glass Units.

C. Glass Association of North America (GANA):
   1. GANA Glazing Manual.

D. Insulating Glass Certification Council (IGCC):
   1. Certified Products Directory.

E. U.S. Consumer Product Safety Commission (CPSC):
   1. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

1.03 DEFINITIONS

A. Full Height Windows: Windows meeting the following conditions:
   1. Lowest edge is less than 18 inches above floor.
   2. Area is greater than 9 square feet.
   3. Walking surface is on both sides either of which is within 36 inches of window.
   4. Window has no minimum 1-1/2-inch railing or mullion at from 24 to 36 inches above floor.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings: Locations of glass types and typical glazing details.

C. Samples: As follows:
   1. Glazing sealants, 2-inch long beads, for color selection.
   2. Glass, 1 square foot of each type specified.

D. Certificates of compliance: Certification that tempered glass in accordance with ANSI Z97.1 and CPSC 16 CFR 1201.

E. Manufacturer's Installation Instructions.

1.05 DESIGN AND PERFORMANCE CRITERIA

A. Comply with the requirements of the building code specified in Section 01_41_00 - Regulatory Requirements.

B. Provide glass and glazing that conforms to CPSC 16 CFR, Part 1201, and exit requirements of the building code.

C. Design and fabricate glazing for resistance to the following loads, as specified in Section 01_81_50 - Design Criteria:
   1. Seismic loading.
   2. Wind loading, based on the requirements for "components and cladding."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in manner to prevent damage.

B. Deliver and store packaged materials in original containers bearing manufacturer's name.

C. Deliver glass affixed with manufacturer's labels showing strength, grade, thickness, type and quality of glass, and for insulating glass, IGCC certification label.

D. Remove labels after installation, inspection, and final acceptance.

1.07 PROJECT CONDITIONS

A. Perform glazing when ambient air temperature is 40 degrees Fahrenheit or above.

1.08 WARRANTY

A. Warrant to replace insulating glass units that exhibit interpane dusting or misting within 10 years with new in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 GLASS

A. Tinted monolithic: ASTM C1036, Type I, Class 2, Quality q3; tinted light bronze; minimum 1/4-inch thick:
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc., Solarbronze.
      b. Guardian Industries Corp., Sunguard, bronze.

B. Tempered: ASTM C1048, Kind FT, Condition A, Type I, Class 1 or Class 2 as scheduled below, Quality q3; tempered without visible tong marks when installed; minimum 1/4-inch thick:
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc., Herculite.
      b. Guardian Industries Corp., equivalent product.

C. Insulating glass units: IGCC Rating Level CBA when tested in accordance with ASTM E773 and E774; hermetically sealed units consisting of minimum 1/4-inch thick, tinted exterior light, minimum 1/4-inch thick, clear interior light, and 1/2-inch wide air space, dehydrated with blended molecular sieve and silica gel desiccant, with metal spacer channel with bent corners and welded splice on 1 vertical side, and polyisobutylene primary and silicone secondary seals.
   1. Manufacturers: One of The following or equal:
      a. PPG Industries, Inc., Twindow.
      b. Guardian Industries Corp., equivalent product.

2.02 GLAZING MATERIALS

A. Setting blocks: Neoprene, 80 to 90 durometer.

B. Spacer blocks: 30 to 40 durometer, thickness equal or greater than insulated window thickness by minimum 6 inches long.

C. Pressure tape: Butyl rubber tape:
   1. Manufacturers: One of the following or equal:
      a. Tremco Mfg. Co., Tremco 440 Tape.
      b. 3-M Co., Weatherban 5422.

D. Sealant: Silicone:
   1. Manufacturers: One of the following or equal:
      a. General Electric Co., Silicone Construction Sealant Series SCS-1200.
      b. Dow Corning Corp., 999-A, Silicone Building and Glazing Sealant.

2.03 SOURCE QUALITY CONTROL

A. Allowable bow and warp tolerances: As measured with glass resting on edge upon two 1 inch wide supports:
   1. Typical: Maximum 1/8 inch in 48 inches.
   2. Tempered glass: Maximum allowed in accordance with ASTM C1048.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine openings to receive glass for defects that would affect glass and glazing work.

B. Verify removal of rivets, screws, bolts, welding fillets, or other projections from clearances in glazing rabbets.

3.02 PREPARATION

A. Examine frames receiving glass and ensure surfaces are clean and dry.

B. Remove dust and oil from glass by wiping clean immediately before installation.

C. Verify that sealants are compatible with glazing materials.

3.03 INSTALLATION OF INSULATED GLASS UNITS

A. In accordance with GANA Glazing Manual, manufacturer's instructions, and accepted shop drawings by the Engineer.

B. Use wet and dry glazing method.

C. Cut glazing tape to length and set against permanent stops to project 1/16 inch above sight line.

D. Place setting blocks at quarter points and no closer than 6 inches from corners.

E. Rest glazing on setting blocks and push against tape for full contact at perimeter of unit.

F. Place glazing gasket.

G. Install removable stop with concealed leg notched to accommodate setting blocks.

H. Align top of gasket with stops.

3.04 INSTALLATION OF GASKETS

A. Gaskets: Install in accordance with manufacturer's instructions.

B. Glazing of interior metal frames: Use pressure or foamed tape and sealant as indicated as required to eliminate rattle and reduce sound transmission.

3.05 SEALANT APPLICATION

A. As specified in Section 07_92_00 - Joint Sealants, unless specifically noted otherwise.

B. Ensure protective coatings have been removed from aluminum surfaces.

C. Where setting blocks and spacer shims are required to be set in sealant, butter with sealant, place into position, and allow to set prior to installation of glass.

D. Neatly tool sealant or compound joints to compress material and improve adhesion. Repair or replace pockets exposed by tooling.

3.06 CLEANING

A. After inspection by Engineer, remove labels and marks from glass in accordance with manufacturer's published recommendations.

B. Clean glass and surrounding surfaces from spatter and blemishes resulting from glazing operations.

C. Clean and polish glass inside and outside.

D. Clean glass with a soft, clean, grit-free cloth and mild soap, detergent, or slightly acidic cleaning solution:
   1. Immediately rinse with clean water and remove excess rinse water with a clean squeegee.
   2. Do not use an abrasive cleaner.

E. Remove grease and miscellaneous glazing materials with commercial solvent. Follow with normal wash and rinse.
   1. Be careful not to damage joint sealers.

3.07 GLASS AND LOCATION SCHEDULE

A. Exterior locations: Glass as follows, unless otherwise scheduled or indicated on the Drawings:
   1. Typical: Insulating, tinted, and tempered.
   2. Entrance doors: Tempered, insulating, and tinted.

END OF SECTION

SECTION 08_91_00

LOUVERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. A variety of stationary, operable, and combination louvers. Also, includes stationary door louvers.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA):
   1. 500-L - Laboratory Methods of Testing Louvers for Rating.
   2. 500-D - Laboratory Methods of Testing Dampers for Rating.
   3. 511 - Certified Ratings Program - Product Rating Manual for Air Control Devices.

B. American Society of Civil Engineers (ASCE):
   1. 7 - Minimum Design Loads and Associated Criteria for Building and Other Structures.

C. ASTM International (ASTM):
   1. E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
   2. E1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
   3. E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
   4. D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products.

D. Testing Application Standard (TAS):
   1. 100A - Standard Test Procedure for Wind and Wind Driven Rain Resistance and/or Increased Windspeed Resistance of Soffit Ventilation Strip and Continuous or Intermittent Ventilation System Installed.

E. Underwriters Laboratories, Inc. (UL).

1.03 TERMINOLOGY

A. The words and terms listed below, are not defined terms that require initial capital letters, but, when used in this Section have the indicated meaning.
   1. Drainable-blade louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.04 SUBMITTALS

A. As specified in Section 23_05_00 - Common Work Results for HVAC.

1.05 QUALITY ASSURANCE

A. Provide louvers with the following, unless otherwise specified:
   1. AMCA certification and rating in accordance with AMCA 511 for air performance and water penetration.

B. Louvers shall be factory engineered to withstand the specified seismic loads.
   1. Minimum design loads shall be calculated to comply with ASCE 7, or local requirements of Authority Having Jurisdiction (AHJ).

PART 2 PRODUCTS

2.01 GENERAL

A. Louver types: As indicated on the Drawings.
   1. Identify louvers with a letter L followed by a number referring to a louver type in this Section.
   2. Identify individual louver size and airflow rates.

B. Accessories:
   1. Provide installation clips and flanged or jamb-mounting styles suitable for the mounting locations.
   2. As indicated on the Drawings.
   3. Provide extended sills for louvers indicated as installed recessed from the exterior wall surface.
   4. Provide stainless steel fasteners unless noted otherwise.
   5. Corrosion protection.
   6. Provide gravity damper for outside air intake and exhaust louvers, unless noted otherwise.

C. Protective coatings for aluminum in contact with concrete or masonry:
   1. Manufacturers: One of the following or equal:
      a. Koppers Co., Inc.
      b. Porter Coatings.
      c. Tarmastic 100.

2.02 DESIGN AND PERFORMANCE REQUIREMENTS

A. Performance: In accordance with AMCA 511 when tested in accordance with AMCA 500.

B. Designed for 20 pounds per square foot wind load.

C. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 23_09_13 - Instrumentation and Control Devices for HVAC.

D. Louvers for severe windstorm applications:
   1. Shall resist the cyclic pressures, static pressures, and missile impact loads in accordance with:
      a. Applicable building codes as specified in Section 01_41_00 - Regulatory Requirements.
   2. Shall resist wind driven rain in accordance with:
      a. TAS 100A:
         1) Louvers shall not require the use of a manual damper to meet the certification requirements.

2.03 STATIONARY WEATHER LOUVERS, TYPE L-1

A. Manufacturers: One of the following or equal:
   1. Greenheck.
   2. Ruskin.

B. Requirements:
   1. Type: Stationary louver with drainable blades.
   2. Frame: 6-inches deep, minimum 0.125-inch thick, Type 6063-T5 aluminum with downspouts and caulking channel provided.
   3. Blades: Minimum 0.125-inch thick, Type 6063-T5 aluminum drainable blades spaced at 6-inch centers, stationary mounted at 37 degrees.
   4. Screens: Removable aluminum frame with aluminum wire; insect screens on intakes and bird screens on exhausts.
   5. Pressure drop (without screen): Maximum 0.15-inch water column for exhaust service and 0.15-inch water column for intake service at 1,000 feet per minute free area velocity.
   6. Water penetration: Maximum 0.01-ounce water per square foot at 1,027 feet per minute free area velocity.
   7. Mullions: Hidden.
   8. Finish: Kynar finish; color as selected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect areas to receive louvers.
   1. Notify the architect of conditions that would adversely affect the installation or subsequent utilization of the louvers.
   2. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Clean opening thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install louvers at locations indicated on the Drawings and in accordance with manufacturer's instructions.

B. As specified in Section 23_05_00 - Common Work Results for HVAC.

3.04 FIELD QUALITY CONTROL

A. Test equipment performance and balance equipment as specified in Section 23_05_93 - Testing, Adjusting, and Balancing for HVAC.

3.05 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

SECTION 09_22_17

NON-LOAD BEARING WALL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Light gauge, screwable type, non-load bearing, metal framing systems for interior walls and partitions.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A653- Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process.
   2. C645 - Standard Specification for Nonstructural Steel Framing Members.
   3. C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
   4. C954 - Standard Specification for Steel Drilled Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84mm) to 0.112 in. (2.84mm) in Thickness.
   5. C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

1.03 SUBMITTAL

A. Product data: Product data for all proposed material for framing system.

1.04 QUALITY ASSURANCE

A. Keep copies of ASTM C754 on site.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials bearing manufacturers' labels indicating manufacturer and brand names.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Non-load bearing wall framing system:
   1. One of the following or equal:
      a. National Gypsum Co.
      b. United States Gypsum Co.
      c. Western Metal Lath Co.

2.02 MATERIALS

A. Studs: ASTM C645, hot-dip galvanized steel, minimum 25 gauge, width as indicated on the Drawings, channel shaped, punched for utility access.

B. Runners, typical: ASTM C645, hot-dip galvanized steel, minimum 25 gauge, channel shaped unpunched web, minimum 1-1/4-inch legs, same widths as studs.

C. Furring channels: ASTM C645, minimum 25 gauge hot-dip galvanized steel, roll formed into 7/8-inch deep by 2-3/4-inch wide hat shaped section.

D. Bracing members: ASTM C645, hot-dip galvanized steel shapes.

E. Resilient furring channels: Minimum 26 gauge galvanized steel, 1/2-inch deep.

F. Anchor plates: ASTM A446, hot-dip galvanized steel, minimum 11 gauge by 4-inch wide by stud spacing with flanges adequate for fastening to stud webs.

G. Fasteners:
   1. General: ASTM C1002, corrosion resistant, for attachment to metal framing 25 gauge and lighter; ASTM C954 for attachment to metal framing 20 gauge and heavier.
   2. Thread and head designs and lengths as recommended by manufacturer for uses and materials involved.

H. Powder actuated fasteners: Type and size suitable for application and as specified in Section 05_12_00 - Structural Steel Framing.

I. Sealant: Polyurethane, as specified in Section 07_92_00 - Joint Sealants.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate installation of bucks, anchors, blocking, and electrical and mechanical construction to be placed in or behind framing.

B. Coordinate erection of system with requirements of door and window frame supports or attachments.

3.02 WALL FRAMING

A. Install metal framing in accordance with ASTM C754.

B. Cut framing members to fit squarely against abutting members. Align stud web openings for installation of utilities. Allow for minimum 1/4-inch clearance between top of stud and top runner web.

C. Do not splice studs.

D. Align runners to configurations indicated on the Drawings.

E. Provide clearance under structural members to prevent stud deflection.

F. Provide extended leg top runners when not possible to provide clearance under structural members.
   1. Drill 3/4-inch long vertical slots, slightly larger than fasteners, at stud locations.

G. Place bead of sealant between runners and construction where water may penetrate.

H. Anchor runners to structure at maximum 2 inches from ends and at maximum 24 inches on center.

I. Anchor runners to:
   1. Concrete with powder actuated fasteners or concrete stub nails.
   2. Steel with bolts or by welding.
   3. Wood with screws penetrating into wood at least 1 inch or nails penetrating into wood at least 1-1/2 inches.
   4. Suspended ceiling grid with toggle or molly bolts.

J. Anchor top runners not anchored directly to structure with brace runners at minimum 36 inches on center.
   1. Fasten brace runner to top runners at right angles to each other.
   2. Bend brace runner ends upward at 45-degree angles.
   3. Anchor brace runner ends to structural members.

K. Place bed of sealant between studs and construction where water may penetrate.

L. Seat studs squarely in track with stud webs and flanges abutting bottom runner webs.

M. Install 2 studs at abutting construction and on each side of openings.

N. Fit runners under and above openings.
   1. Secure cripples between sill and header, and bottom and top runners at minimum 16 inches on center, unless otherwise indicated on the Drawings.

O. Install minimum 3 studs at metal framing corners.

P. Space studs at 16 inches on center, unless otherwise indicated on the Drawings.

Q. Fasten studs to runners tightly.
   1. Loosely fasten studs to extended leg runners through slotted holes.

R. Fasten studs next to openings at framing intersections and at corners to typical runners with 2 screws on each side.

S. Do not tie framing components together with wire.

T. Make framing system with bracing members.

U. Fasten anchor plates to stud webs where required to support wall-mounted accessories, fixtures, or hardware.
   1. Align surfaces of anchor plates flush with stud flanges.

V. Special techniques:
   1. Framing components may be fabricated into panels prior to erection.
   2. Brace panels with additional bracing members to prevent racking.
   3. Prevent local member distortion when handling panels.

3.03 FURRING CHANNEL INSTALLATION

A. Space furring channels at maximum 24 inches on center.

B. Nest end splices with minimum 8-inch overlaps.
   1. Secure with 2 fasteners.

C. Attach channels at maximum 24 inches on center through alternate flanges.

3.04 TOLERANCES

A. Vertical alignment of studs: Within 1/8 inch in 10 feet.

B. Horizontal alignment of walls: Within 1/8 inch in 10 feet.

C. Stud spacing: Within 1/8 inch, provided that cumulative error does not exceed requirements of finish materials.

D. Squareness of prefabricated panels: Within 1/8 inch within length of panel.

END OF SECTION

SECTION 09_96_01

HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Coatings, including coating systems, surface preparation, application requirements, and quality control requirements.

1.02 REFERENCES

A. Abbreviations:
   1. CMU - Concrete masonry units.
   2. CSA - Coating system applicator. Specialty subcontractor retained by the Contractor to install the coating systems specified in this Section.
   3. CSM - Coating system manufacturer.
   4. CTR - Coating system manufacturer's technical representative.
   5. DFT - Dry-film thickness. Thickness of cured film, usually expressed in mils (0.001 inch).
   6. VOC - Volatile organic compound. Portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing; expressed in grams per liter (g/l) or pounds per gallon (lb/gal). VOC is determined by EPA Method 24.
   7. WFT - Wet film thickness. Coating thickness as measured immediately after application. Usually expressed in mils (0.001 inch).

B. Standards:
   1. ASTM International (ASTM):
      a. D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
      b. D2200 - Standard Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces.
      c. D3359 - Standard Test Methods for Rating Adhesion by Tape Test.
      d. D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
      e. D4262 - Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      f. D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
      g. D4285 - Standard Test Method for Indicating Oil or Water in Compressed Air.
      h. D4414 - Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
      i. D4417 - Standard Test Methods for Field Measurement of Surface Profile of Blast-Cleaned Steel.

j. D4541 - Standard Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
k. D4787 - Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
l. D5162 - Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates.
m. D7234 - Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
n. E337 - Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures).
o. F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
p. F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In-situ Probes.

2. International Concrete Repair Institute (ICRI):
   a. 310.2 - Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
3. NACE International (NACE):
   a. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
   b. SP0188 - Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. National Association of Pipe Fabricators (NAPF):
   a. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings.
5. NSF International (NSF):
   a. 61 - Drinking Water System Components - Health Effects.
6. Occupational Safety and Health Administration (OSHA).
7. Society of Protective Coatings (SSPC):
   a. Glossary - SSPC Protective Coatings Glossary.
   b. Guide 6 - Guide for Containing Surface Preparation Debris Generated during Paint Removal Operations.
   c. PA 1 - Shop, Field, and Maintenance Painting of Steel.
   d. PA 2 - Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   e. PA 9 - Measurement of Dry Coating Thickness Using Ultrasonic Gages.
   f. QP 1 - Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors.
   g. SP 1 - Solvent Cleaning.
   h. SP 3 - Power Tool Cleaning.
   i. SP 5 - White Metal Blast Cleaning.
   j. SP 10 - Near-White Metal Blast Cleaning.
   k. SP 11 - Power Tools Cleaning to Bare Metal.
   l. SP 13 - Surface Preparation of Concrete.
   m. SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
   n. SP COM - Surface Preparation Commentary.
   o. SP VIS 1 - Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.
   p. SP WJ-1 - Waterjet Cleaning of Metals—Clean to Bare Substrate.

q. SP WJ-2 - Waterjet Cleaning of Metals—Very Thorough Cleaning.
r. SP WJ-3 - Waterjet Cleaning of Metals—Thorough Cleaning.
s. SP WJ-4 - Waterjet Cleaning of Metals—Light Cleaning.

1.03 TERMINOLOGY

A. Definitions used in this Section are in accordance with definitions referenced in ASTM D16, ASTM D3960, and SSPC Glossary of Definitions.

B. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. Abrasive: Material used for blast cleaning, such as sand, grit, or shot.
2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.
3. Anchor Pattern: Profile or texture of prepared surface(s).
4. Biogenic Sulfide Corrosion: Corrosion caused by sulfuric acid formed when *Thiobacillus* bacteria metabolizes hydrogen sulfide.
5. Bug Holes: Small cavities resulting when air bubbles are entrapped in the surface of formed concrete during placement and consolidation.
6. Coating/Paint/Lining Thickness: Total thickness of primer, intermediate, and/or finish coats after drying or curing.
7. Dew point: Temperature a given air/water vapor mixture starts to condense.
8. Dry to Recoat: Time interval between material application and its ability to receive the next coat.
9. Dry to Touch: Time interval between material application and its ability to tolerate a light touch without coating damage.
10. Drying Time: Time interval between application and material curing.
11. Exposed Surface: Any indoor or outdoor surface not buried or encased.
12. Feather Edging: Reducing coating thickness at its edge to blend with existing surrounding coating.
13. Feathering: Tapering off a wet edge with a comparatively dry brush.
14. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.
15. Field Coat: Application of a surface coating system at the work site.
16. Finish Coat: Final coat in a paint system, including texture, color, smoothness of surface, and other properties affecting appearance.
17. Hold Point: A defined point, specified in this Section, at which work shall be halted for inspection.
18. Holiday: A discontinuity, skip, void, or pinhole in coating or coating system film that exposes the substrate.
19. Honeycomb: Segregated and porous surface of hardened concrete due to insufficient consolidation.
20. Hydroblast: High or ultra-high-pressure water jet surface preparation.
21. Immersed/Immersion: A service condition in which substrate is submerged, is immediately above liquids, or is subject to frequent wetting, splashing, or washdown.
22. Incompatibility: One coating's inability to overlay another coating or surface as evidenced by bleeding, poor bonding, or lifting of old coating; inability of a coating to bond to a substrate.
23. Laitance: A thin, weak, brittle layer of cement and aggregate fines on a concrete surface.

24. Mil: 0.001 inch.
25. Overspray: Dry spray, particularly paint bonded to an unintended surface.
26. Pinhole: A small diameter discontinuity in a coating or coating system film, created by offgassing from a void in a concrete or masonry substrate causing a void between coats or exposing the substrate. Usually caused by coating application while temperature is rising.
27. Pot Life: Time interval after components are mixed and coating can be satisfactorily applied.
28. Prime Coat: First full paint coat applied to a surface when using a multicoat system. Primers adhere to a new substrate, protect the substrate, and promote adhesion of subsequent coats of paint. The prime coat on metal surfaces is the first full coat and does not include solvent wash, grease emulsifiers, or other pretreatment applications.
29. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-based material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.
30. Shelf Life: Maximum storage time a material may be stored without losing its usefulness.
31. Shop Coat: 1 or more coats applied in an off-site shop or plant before shipment to work site where field or finishing coat(s) are applied.
32. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
33. Stripe Coat: A separate brush coat of paint applied to all weld seams, pits, nuts/bolts/washers, and edges. This coat shall not be applied until previous coats have cured. Once applied, the coat shall be allowed to cure before subsequent coats are applied.
34. System: Protective film with 1 or more coats applied in a predetermined order, including surface preparation and quality control requirements.
35. Thick Film Coating System: A coating system applied with a minimum dry film thickness of 25 mils.
36. Tie Coat: An intermediate coat that bonds different types of paint material, improving succeeding coat adhesion.
37. Touch-Up Painting: Application of paint on previously painted surfaces to repair marks, scratches, and deteriorated or damaged areas to restore the appearance and performance of the coating.
38. Water Blast: An alternative to air abrasive blast cleaning that can be used with or without abrasive injection. Water cleaning at pressures up to 5,000 pounds per square inch is called low-pressure water cleaning or power washing. High-pressure water cleaning uses water pressures between 5,000 and 10,000 pounds per square inch. Water jetting is water blasting with added abrasive at pressures between 10,000 and 25,000 pounds per square inch. Ultra-high-pressure water jetting is water blasting at pressures above 25,000 pounds per square inch.
39. Weld Splatter: Beads of non-structural weld metal that adhere to the surrounding surface, removed as part of surface preparation.

1.04 SUBMITTALS

A. As specified in Section 01_33_00 - Submittal Procedures, submit the following:
   1. Schedule of proposed coating materials.
   2. Schedule of surfaces to be coated with each coating material.
   3. Dehumidification and heating plan.

4. Product data:
    a. Physical properties of coatings, including the following:
        1) Solids content.
        2) Ingredient analysis.
        3) VOC content.
        4) Temperature resistance.
        5) Typical exposures and limitations.
        6) Manufacturer's standard color chips.
    b. Compliance with regulatory requirements:
        1) VOC limitations.
        2) Lead compounds and polychlorinated biphenyls.
        3) Abrasives and abrasive blast cleaning techniques and disposal.
        4) Methods for tenting blasting areas and methods to protect existing equipment from dust and debris.
        5) NSF certification of coatings for potable water supply systems.
    c. CSM's current printed recommendations and product datasheets for coating systems, including:
        1) Surface preparation recommendations.
        2) Primer type.
        3) Maximum dry and wet-mil thickness per coat and number of coats.
            a) Coating coverage worksheets.
        4) Minimum and maximum curing time between coats, including atmospheric conditions for each.
        5) Curing time before submergence in liquid.
        6) Thinner to be used for each coating.
        7) Ventilation requirements.
        8) Minimum and maximum atmospheric conditions during which the paint shall be applied.
        9) Allowable application methods.
        10) Maximum allowable substrate moisture content.
        11) Maximum shelf life.
        12) Requirements for transportation and storage.
        13) Mixing instructions.
        14) Shelf life.
        15) Material Pot life.
        16) Precautions for applications free of defects.
        17) Method of application.
        18) Drying time of each coat, including prime coat.
        19) Compatible prime coats.
        20) Limits of ambient conditions during and after application.
        21) Required protection from sun, wind, and other conditions.
        22) Touch-up requirements and limitations.
        23) Minimum adhesion of each system submitted in accordance with ASTM D4541 and ASTM D7234.
    d. Samples: Include 8-inch square drawdowns or brushouts of topcoat finish when requested. Identify each sample as to finish, formula, color name and number, sheen name, and gloss units.
    e. Affidavits signed by an officer of the CSM’s corporation attesting to full compliance of each coating system component with current federal, state, and local air pollution control regulations and requirements.
    f. List of cleaning and thinner solutions allowed by the CSMs.

g. Storage requirements, including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.
h. Thick film coating systems (greater than 25 mils):
1) CSM's detailed written instructions for coating system treatment and graphic details for coating system terminations in coated structures, including pipe penetrations, metal embedments, gate frames, and other terminations encountered.
2) Include detail treatment for coating system at concrete joints.
3) Manufacturer's Representative's (CTR) Field Reports.

5. Quality assurance Submittals:
a. Quality assurance plan.
b. Qualifications of CSA, including:
1) List of Similar Projects.
a) Name and address of project.
b) Year of installation.
c) Year placed in operation.
d) Point of contact: Name and phone number.
2) Provide a minimum of 5 project references, each including contact name, address, and telephone number where similar coating work has been performed by their company in the past 5 years.
c. CSA Reports:
1) Written daily quality control inspection reports.
d. CTR Reports:
1) Reports on visits to project site to view and approve surface preparation of structures to be coated.
2) Reports on visits to project site to observe and approve coating application procedures.
3) Reports on visits to coating plants to observe and approve surface preparation and coating application on shop-coated items.

1.05 QUALITY ASSURANCE

A. CSA qualifications:
1. Minimum of 5 years of experience applying specified type or types of coatings under conditions similar to those of the Work:
a. Provide qualifications of applicator and references listing 5 similar projects completed in the past 5 years.
2. SSPC-QP 1 certified.
3. Manufacturer-approved applicator when manufacturer has approved applicator program or when required in these specifications.

B. CTR qualifications:
1. Certification, one of the following:
a. NACE Level 2 or 3 Certified Coating Inspector.
b. SSPC Level 3 Protective Coatings Inspector.
2. Minimum of 5 years of experience evaluating application of manufacturer's coatings under conditions similar to those of the Work:
a. Provide CTR qualifications and references listing 5 similar projects completed in the past 5 years.

C. Regulatory requirements: Comply with governing agencies' regulations by using coatings in accordance with to their VOC limits.
   1. Lead-based coatings are not permitted.
   2. Do not use coal-tar epoxy in contact with drinking water or exposed to ultraviolet radiation.

D. Certification:
   1. Certify that applicable pigments resist deterioration when exposed to hydrogen sulfide and other sewage gases.
   2. Product data shall designate coating as being suitable for wastewater service.

E. Pre-installation conference: Conduct as specified in Section 01_31_19 - Project Meetings.
   1. Coordinate Hold Point schedule.

F. Field samples:
   1. Prepare and coat a minimum 100-square-foot area of each system between corners or limits such as control or construction joints.
   2. Approved field sample may be part of the Work.

G. Obtain approval before coating other surfaces. Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

H. CSM services:
   1. CSA shall arrange for CTR to attend pre-installation conferences.
   2. Visit the project site periodically to consult on and inspect specified surface preparation and application Hold Points.
   3. Visit coating plants to observe and approve surface preparation procedures and coating application of items to be shop primed and coated.
   4. CTR shall provide written inspection reports.

I. Quality control requirements:
   1. Contractor shall be responsible for the workmanship and quality of the coating system installation.
      a. Inspections by Owner, Engineer, CSA, or CTR will not relieve or limit Contractor's responsibilities.
   2. In accordance with this specification's requirements and the standards referenced in this Section. Changes in the coating system application requirements will be allowed only with the Engineer's written acceptance.
   3. Specially trained crews with experience applying the specified coating system coating are required for:
      a. Coating application using plural component spray equipment or other specialty equipment.
      b. Coating with specialty linings for severe service conditions, including floor coatings, and with linings for corrosive headspaces or secondary containment areas.
   4. CTR shall specially train personnel for coating systems as specified in Attachment B - Coating Detail Sheets.
      a. CSM shall approve personnel in writing applying the coating system.

5. Do not use contaminated, outdated, diluted materials, and/or materials from previously opened containers.
6. Identify inspection access points used by Owner's or Engineer's personnel.
7. Provide ventilation, ingress, egress, or other means as necessary for Owner's or Engineer's personnel to safely access the work areas.
8. Conduct and continually inspect work so the coating system is installed as specified. CSM shall provide written directions to correct coating work not in accordance with the specifications or is otherwise unacceptable.
9. Provide written daily reports summarizing test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the coating system application.
    a. Determine relative humidity in accordance with ASTM E337. Confirm other conditions, such as proper protective measures for surfaces not to be coated and safety requirements for personnel.
        1) Measure daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
        2) Determine the acceptability of weather and/or environmental conditions within the structure in accordance with the CSM's requirements.
    b. Monitoring surface preparation: Spot check cleanliness, surface profile, and surface pH testing at least 3 times daily. Check each surface at least once. In accordance with:
        1) ASTM D4262.
        2) ASTM D4263.
        3) ASTM D4417.
        4) ICRI 310.2 requirements.
        5) SSPC Surface Preparation Standards.
    c. Confirm that compressed air used for surface preparation or blow-down cleaning is free of oil and moisture.
    d. Monitor surface preparation daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
    e. Do not apply coatings when environmental conditions are outside of the CSM's published limits.
    f. Monitoring coatings application: Continuously inspect, measure, and record the wet film thickness and general film quality (visual inspection) for runs, sags, pinholes, holidays, etc., during coating.
        1) Perform WFT measurements in accordance with ASTM D4414.
    g. Post cure evaluation: Measure and inspect the overall dry film thickness on all surfaces.
        1) Conduct a DFT survey and perform adhesion testing, holiday detection, or cure testing as required in this Section and/or the CSM’s written instructions.
        2) Perform applicable tests in accordance with ASTM D4541, ASTM D4787, ASTM D5162, ASTM D7234, SSPC-PA 1, SSPC-PA 2, SSPC-PA 9, and other pertinent standards and recommended practices.

J. Inspection at Hold Points:
    a. Coatings application: At the beginning of coating system application, measure, record, and confirm acceptability of surface and ambient air

temperature and humidity. Inspect applicator's equipment for serviceability and suitability for coatings application.
1) Observe conditions during the pre-application meeting.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products as specified in Section 01_60_00 - Product Requirements.

B. Immediately remove unspecified and unapproved coatings from Project site.

C. Deliver new labeled, unopened containers:
1. Do not deliver materials after manufacturer's expiration date or over 12 months from manufacturing date, whichever is more stringent. Store materials in well-ventilated enclosed structures and protect from weather and excessive heat or cold in accordance with the CSM’s recommendations.
a. Store flammable materials in accordance with federal, state, and local requirements.
b. Store rags and cleanup materials appropriately to prevent fire and spontaneous combustion.
2. Store and dispose of hazardous waste in accordance with federal, state, and local requirements. This requirement specifically applies to waste solvents and coatings.
3. Container labels shall show the following:
a. Brand name or product title.
b. CSM's batch number.
c. CSM's manufacture date.
d. CSM's name.
e. Generic material type.
f. Application and mixing instructions.
g. Hazardous material identification label.
h. Shelf life expiration date.
i. Color.
j. Mixing and reducing instructions.
4. Clearly mark containers to indicate safety hazards associated with the use of or exposure to materials.

1.07 PROJECT CONDITIONS

A. Apply coatings to dry surfaces.
1. Surface moisture: Comply with manufacturer's requirements or as specified in this Section.
a. Plaster and gypsum wallboard: 12 percent.
b. Masonry and concrete block: 12 percent.
c. Interior located wood: 15 percent.
d. Concrete floors: Moisture vapor transmission rate of no more than 3.0 pounds per 1,000 square feet per 24 hours in accordance with ASTM F1869 or relative humidity no greater than 80 percent if tested in accordance with ASTM F2170 unless the CSM's recommendations are more restrictive.

e. Concrete structures: Negative results from Plastic Sheet Test in accordance with ASTM D4263, and maximum of 80 percent relative humidity in accordance with ASTM F2170.

B. Do not apply coatings when the following conditions exist. If such conditions exist, provide containment, covers, environmental controls, and other necessary measures.
   1. During rainy, misty, or damp weather, or to surfaces with frost or condensation.
   2. When the surface temperature is below 10 degrees Fahrenheit above the dew point.
   3. When ambient or surface temperature:
      a. Is less than 55 degrees Fahrenheit unless manufacturer allows a lower temperature.
      b. Is less than 65 degrees Fahrenheit for clear finishes unless manufacturer allows a lower temperature.
      c. Exceeds 90 degrees Fahrenheit unless manufacturer allows a higher temperature.
      d. Exceeds manufacturer's recommendation.
   4. When relative humidity is higher than 85 percent.
   5. Under dusty or adverse environmental conditions.
   6. When light on surfaces measures less than 15 foot-candles.
   7. When wind speed exceeds 15 miles per hour.

C. Apply coating only under evaporation conditions rather than condensation.
   1. Use dehumidification equipment, fans, and/or heaters inside enclosed areas to maintain required atmospheric and surface temperature requirements for proper coating application and cure.
   2. Measure and record relative humidity and air and surface temperatures at the start and end of each shift to confirm proper humidity and temperature levels inside the work area.
      a. Submit test results.

D. Continuously ventilate, dehumidify, and heat enclosed spaces with high humidity during surface preparation, coating application, and curing.
   1. Maintain minimum air temperature of 55 degrees Fahrenheit and 10 degrees Fahrenheit above the dew point.
   2. Maintain dew point of at least 10 degrees Fahrenheit less than the temperature of the coldest part of the structure where work is performed.
   3. Reduce dew point temperature in conditioned space by at least 10 degrees Fahrenheit within 20 minutes.
   4. Seal work areas and maintain positive pressure per dehumidification equipment supplier's recommendations.
   5. Maintain these conditions before, during, and after application to ensure proper adhesion and cure of coatings for no less than:
      a. Entire curing period.
      b. 8 hours after coating.

E. Systems:
   1. Site electrical power availability as specified in Section 01_50_00 - Temporary Facilities and Controls.

2. Internal combustion engine generators may be used.
    a. Obtain required permits and provide air pollution and noise control devices on equipment as required by permitting agencies require.
    b. Comply with state, federal, and local fire and explosion protection measures when locating and operating generator.
    c. Locate engine generator outside hazardous classified areas in accordance with NFPA 820.
    d. Provide daily fuel service for generator for duration of use.
3. Dehumidification:
    a. Provide desiccant or refrigeration drying.
    b. Use only desiccant types with a rotary desiccant wheel capable of continuous operation.
    c. Liquid, granular, or loose lithium chloride drying systems are not acceptable.
4. Heating:
    a. Use electric, indirect combustion, or steam coil.
    b. Direct-fired combustion heaters are not acceptable heat sources during abrasive blasting, coating application, or coating cure.
5. Filters:
    a. Use a filtration system for dust removal designed to not interfere with dehumidification equipment's ability to control dew point and relative humidity inside the reservoir.
    b. Do not allow air from the working area or dust filtration equipment to recirculate through thein dehumidifier during coating application or when solvent vapors are present.
6. Design and Submittals:
    a. Prepare and submit dehumidification and heating plan, including all equipment and operating procedures.
    b. Suppliers of services and equipment shall have at least 3 years of experience in similar applications.

F. Provide containment and ventilation system components in accordance with SSPC-Guide 6, Level 3 and as required for hazardous materials.

1.08 MAINTENANCE

A. Provide table of products applied organized by surface type. List coating manufacturer, color, color formulation, distributor name, telephone number, and address.

1.09 CTR RESPONSIBILITIES

A. General:
    1. Attend pre-installation conference.
    2. Perform onsite application training.
    3. Periodically inspect coating system application.

B. Coating system installation training:
   1. Provide a minimum of 8 hours of classroom and off-site training for application personnel and supervisory personnel in one of the following ways:
      a. Train a minimum of 2 supervisory personnel and 2 application personnel.
      b. Submit a letter from the CSM stating that CSM approves the supervisory and application personnel, listed by name and responsibility, and no additional training is required.
   2. CTR can train up to 14 application personnel and 3 supervisory personnel at a time.
   3. Minimum training requirements:
      a. Explain in detail the mixing, application, curing, and termination requirements.
      b. Provide hands-on demonstration of coating system mixing.
      c. Explain in detail the ambient condition requirements for temperature and humidity.
      d. Explain in detail the surface preparation requirements.
      e. Explain in detail the re-coat times, cure times, and related ambient condition requirements.
      f. Write a letter stating that training was satisfactorily completed by the personnel, listed by name and responsibility.
   4. Provide special training as specified in the Coating Detail Sheets.

C. Coating system inspection:
   1. CTR inspection is in addition to the CSA's inspection as specified in this Section.
   2. Be on-site to oversee:
      a. Coating application at least once a week.
      b. End of surface preparation.
      c. During coating application.
      d. Post-cure inspection.
   3. Routinely inspect and verify in writing that application personnel have successfully performed surface preparation, filler/surfacer application, coating system application, and Quality Control Inspection in accordance with this Section and to warrantable quality.
   4. Perform the following activities to confirm conformance with the specifications:
      a. Inspect ambient conditions during coating system installation at Hold Points for conformance with the specified requirements.
      b. Inspect each coated surface type and coating system applied to verify the following:
         1) Cleanliness.
         2) Surface pH for concrete substrates.
         3) Confirm surface preparation of substrates where coating system will terminate or will be applied for conformance to the specified application criteria.
      c. Verify surface profile of substrates by completing the following:
         1) Inspect preparation and application of coating detail treatment at terminations, transitions, metal embedments in concrete, and joints and cracks in substrates.
         2) Inspect application of filler/surfacer materials for concrete and masonry substrates.
         3) Verify proper mixing of coating materials.

4) Inspect application of primers and finish coats, including wet and dry film thickness.
5) Inspect coating systems for proper cure times and conditions.

d. Review adhesion testing of cured coating systems.
e. Review coating system continuity testing.
f. Inspect and record representative-localized repairs.
g. Conduct final review of completed coating system installation.
h. Prepare and submit site visit reports after each site visit to document that the coating work is in accordance with the CSM's Recommendations.

D. Final report:
1. Prepare a final report, after coating work ends, summarizing each day's test data, observations, drawings, and photographs.
a. Include substrate conditions, ambient conditions, and application procedures observed during the CTR's site visits.
b. Include a statement that completed work was performed in accordance with the requirements of the CSM's recommendations.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Coating materials shall be formulated for environments encountered in water and wastewater treatment processes.

B. Coating materials that come in contact with water distributed as potable water shall be certified in accordance with NSF 61.

2.02 MATERIALS

A. General:
1. Product requirements: As specified in Section 01_60_00 - Product Requirements.

2.03 COATING SYSTEMS IDENTIFICATION

A. Naming conventions: Coating Systems Identifications contain the elements defined in Table 1.

Table 1. Coating System Identification Elements

First Element	**-**	**Second Element**	**-**	**Third Element**	**-**	**Fourth Element (optional)**
3 or 4 alpha characters		1-3 alpha characters		1 number		3 or 4 alpha characters
Coating Type		Substrate		System Number		Additional Substrate or Special Condition
Example: EPX	-	C	-	6	-	BSC

1. First element identifies the coating type using the following abbreviations:
a. ACR: Acrylic.

b. CTE: Coal tar epoxy.
c. ELA: Elastomeric acrylic.
d. EPU: Epoxy-polyurethane.
e. EPX: Epoxy.
f. POL: Polyurethane.
g. SIL: Silicone.
h. SILX: Siloxane or silane.
i. VE: Vinyl ester.

2. Second element identifies the substrate using the following abbreviations:
   a. C: Concrete or masonry.
   b. F: Concrete flooring.
   c. FRP: Fiber-reinforced plastic.
   d. GM: Galvanized metal.
   e. M: Metal.
   f. PVC: Polyvinyl chloride, chlorinated polyvinyl chloride.
3. Third element identifies the sequential system number.
   a. For example, EPX-C-2 is the second standard epoxy coating system for concrete substrates.
4. Fourth element is optional and identifies the additional substrate or special condition with the following abbreviations:
   a. PWS: Potable water service applications (NSF-61 approved).
   b. BSC: Biogenic sulfide corrosion-resistant applications in wastewater.
   c. BG: Below grade or buried.
   d. OZ: Organic zinc primer, epoxy polyurethane system.
   e. SC: Secondary containment.

2.04 PRODUCTS FOR COATING SYSTEMS

A. Products: As specified in Attachment B - Coating Detail Sheets.

B. Cleaning solvents:
   1. Requirements for solvent wash, solvent wipe, or cleaner used, including, but not limited to, those used for surface preparation in accordance with SSPC-SP 1:
      a. Emulsifying type.
      b. Containing no phosphates.
      c. Biodegradable.
      d. Does not damage zinc.
      e. Compatible with the specified primer.
      f. Complying with applicable air-quality control board requirements.
   2. Use clean white cloths and clean fluids in solvent cleaning.

PART 3 EXECUTION

3.01 GENERAL PROTECTION REQUIREMENTS

A. Protect adjacent coated surfaces from coatings and damage associated with coating work. Repair damage resulting from inadequate or unsuitable protection.

B. Use drop cloths and other coverings to protect adjacent surfaces not to be coated against spatter and droppings.

C. Mask off surfaces of items not to be coated or remove items from area.

D. Furnish and deploy sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and, in particular, surfaces within storage and preparation areas.

E. Place coating waste, cloths, and material that may pose a fire hazard in closed metal containers and remove daily from site.

F. Remove electrical plates, surface hardware, fittings, and fasteners before coating application.
   1. Carefully store, clean, and replace items after completing coating in each area.
   2. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finishes.

G. Erect and maintain protective enclosures in accordance with SSPC-Guide 6.

H. Protect the following surfaces from abrasive blasting by masking or by other means:
   1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
   2. Machined surfaces for sliding contact.
   3. Surfaces to be assembled against gaskets.
   4. Surfaces of shafting where sprockets will be fit.
   5. Surfaces of shafting where bearings will be fit.
   6. Machined bronze surfaces, including slide gates.
   7. Cadmium-plated items, except cadmium-plated, zinc-plated, or sherardized fasteners used to assemble equipment requiring abrasive blasting.
   8. Galvanized items, unless scheduled to be coated.

I. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by spent abrasive blast media, dust, or dirt entering such equipment.

J. Schedule cleaning and coating to keep dust and spray from the cleaning process from falling on wet, newly coated surfaces.
   1. Whenever possible, coordinate with other trades and complete surface preparation and coating work before installing hardware, hardware accessories, nameplates, data tags, electrical fixtures, and similar uncoated items that will be in contact with coated surfaces. Mask machined surfaces, sprinkler heads, and other small items that will not be coated.
   2. After completing coating, reinstall removed items.
   3. Disconnect and move equipment adjacent to walls to clean and coat equipment and walls. Replace and reconnect equipment after coating.

3.02 GENERAL SURFACE PREPARATION REQUIREMENTS

A. Prepare surfaces in accordance with CSM's instructions unless more stringent requirements are specified in this Section.

B. Coating detail sheets in Attachment B - Coating Detail Sheets include additional surface preparation requirements.

C. Follow more stringent requirement if information conflicts.

D. Where required by the Owner's representative, a NACE International certified coatings inspector, provided by the Owner, will inspect and approve surfaces to be coated before applying a coating.
   1. CSA shall coordinate coating inspections.
      a. Identify coating inspection Hold Points during the pre-installation conference.
      b. Provide at least 2 days' notice before inspection.
   2. Correct surface defects identified by the inspector at no additional cost to the Owner.

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT PREPARATION

A. Identify equipment, ducting, piping, and conduit as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment, Section 40_05_00.03 - Pipe Identification, and Section 26_05_53 - Identification for Electrical Systems.

B. Remove grilles, covers, and access panels for mechanical and electrical system and coat separately.

C. Prepare and finish coat equipment primed by the manufacturer using specified intermediate and top coats, as applicable, and color selected by the Owner.

D. Prepare, prime, and coat both insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with material not requiring coating, or with a prefinished coating.

E. Replace identification markings on mechanical or electrical equipment when coated over or spattered.

F. Prepare and coat interior surfaces of air ducts and convector and baseboard heating cabinets visible through grilles and louvers with 1 coat of flat black paint to limit of sight line.

G. Prepare and coat dampers exposed immediately behind louvers, grilles, and convector and baseboard heating cabinets to match face panels.

H. Prepare and coat exposed conduit and appurtenances occurring in finished areas with color and texture to match adjacent surfaces.

I. Prepare and coat sides' front, back, and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

J. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming, and numbering, in accordance with the Contract Documents.

3.04 CLEANING OF NEW AND PREVIOUSLY COATED OR NEW SURFACES

A. Utilize cleaning agent to remove soluble salts, such as chlorides, from concrete and metal surfaces:
   1. Cleaning agent: Biodegradable non-flammable and containing no VOC.
   2. Manufacturers: The following or equal:
      a. CHLOR*RID International, Inc.
         1) Complete soluble salt removal with steam or warm water cleaning.
   3. Test cleaned surfaces to ensure removal of soluble salts. Carry out additional cleaning as needed.
   4. Complete final surface preparation before applying new coating system in strict accordance with CSM's printed instructions.

3.05 BLAST CLEANING

A. Surface preparation requirements:
   1. Do not reuse spent blast abrasive.
   2. Ensure that filter compressed air used for blast cleaning is free of condensed water and oil.
      a. Clean moisture traps at least once every 4 hours or more frequently, as required, to prevent moisture from entering the abrasive blasting equipment air supply.
      b. Check blast air for moisture and oil after each cleaning in accordance with ASTM D4285.
   3. Install oil separators just downstream of compressor discharge valves and at the discharge point of blast pot discharges. Check separators on the same frequency as the moisture traps.
   4. Keep regulators, gauges, filters, and separators on compressor air lines to blasting nozzles operational at all times.
   5. Install an air dryer or desiccant filter drying unit to dry the compressed air before blast pot connections. Use and maintain the dryer throughout surface preparation work.
   6. Use a venturi-type, or other high velocity-type, abrasive blast nozzles supplied with at least 100 pounds per square inch gauge air pressure at the nozzle and enough volume to obtain appropriate blast cleaning production rates and surface cleanliness.
   7. Provide airborne particulate evacuation and filtering that meets OSHA safety standards. Maintain optimal visibility both to clean and provide the specified surface profile and to allow inspection of the substrate during surface preparation work.
   8. If prepared and cleaned metallic substrates become contaminated between final surface preparation work and coating system application, or if the prepared substrate darkens or changes color, re-clean by water blasting, or abrasive blast cleaning as appropriate until the specified degree of cleanliness is restored.

B. Water jetting or water blasting:
   1. Use water jetting or water blasting for recoating or relining where an adequate surface profile exists.
   2. Perform water jetting or water blasting in accordance with SSPC-SP 13 and SSPC-WJ-1, WJ-2, WJ-3, WJ-4.

3.06 PREPARATION REQUIREMENTS FOR CONCRETE SURFACES

A. Cure for at least 28 days before coating.

B. Remove degraded concrete using abrasive blast cleaning or high or ultra-high-pressure water jetting, chipping, or other abrading tools until achieving a sound, clean substrate. Remove bruised or cracked concrete.

C. Prepare substrate cracks and areas requiring resurfacing; perform detail treatment, including, but not limited to, terminating edges in accordance with the CSM's recommendations, and as indicated on the Drawings.
   1. Prepare concrete surfaces in accordance with SSPC-SP 13.

D. Prepare concrete surfaces in accordance with SSPC-SP 13.
   1. Inspect concrete surfaces to select appropriate surface preparation method to provide a suitable substrate for the specified coating system.
   2. Use blast cleaning or other means to expose the complete perimeter of air voids or bug holes. Do not leave shelled over, hidden air voids beneath the exposed concrete surface.
   3. Repair concrete defects and physical damage.
   4. Clean concrete surfaces of dust, mortar, formwork, fins, loose concrete particles, form release materials, oil, and grease.
   5. Fill voids to provide surface as specified in Section 03_35_29 - Concrete Finishes.

E. Provide clean substrate visually free of calcium sulfate, loose, coarse, or fine aggregate, laitance, loose hydrated cement paste, and otherwise harmful substances.
   1. Confirm concrete surface minimum pH of 9.0 with surface pH testing.
   2. If after surface preparation the surface pH remains below 9.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.

F. Prepare concrete surface for coating in accordance with SSPC-SP 13.
   1. Provide ICRI 310.2 minimum No. 3 concrete surface profile (CSP) or as specified on Coating Detail Sheets.
   2. Evaluate profile of the prepared concrete using ICRI 310.2 surface profile replicas.

G. Blast clean cementitious repair mortars or grouts to the same profile and degree of cleanliness requirements required for concrete substrates.

H. Blast clean polymer-based surfacers or waterborne modified cementitious surfaces only if they have exceeded the CSM's recommended recoat time.

I. Vacuum concrete surfaces before coating application, leaving a dust free, sound concrete substrate.
   1. Thoroughly clean concrete surfaces to be coated to remove loose dirt and spent abrasive.
   2. Remove debris produced by blast cleaning from the structures to be coated, and legally dispose of it off-site.

J. Test moisture content of concrete to be coated:
   1. Conduct ASTM D4263 plastic sheet test at least once for every 500 square feet of surface area to be coated.
      a. Any moisture on plastic sheet after test period constitutes a non-acceptable test, and the concrete must be dried further.
   2. Conduct ASTM F1869 test at least once for every 1,000 square feet of concrete floor surface area to be coated.
   3. Conduct ASTM F2170 one relative humidity moisture test at least once for each 500 square feet of non-floor concrete surface area where the opposite side is exposed to soil or water.
      a. Waterproof surfaces exposed to soil or water where specified in Section 07_11_00 - Dampproofing.
   4. Comply with specified minimum moisture content and CSM's written recommendations for moisture vapor transmission rates or relative humidity values.

K. Masonry surfaces:
   1. Cure for at least 28 days before coating.
   2. Prepare masonry surfaces to remove chalk, laitance, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
   3. Wash and scrub masonry surfaces with clear water. Do not use muriatic acid.
   4. Seal or fill masonry surfaces with a sealer or block filler compatible with the specified primer after cleaning.
   5. Confirm that masonry surfaces are dry before coating application.
      a. If using pressure washing or low-pressure water blast cleaning for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or until the minimum ambient temperature is 70 degrees Fahrenheit before coating.

3.07 GENERAL PREPARATION REQUIREMENTS FOR METALLIC SURFACES

A. Remove rust, scale, and welding slag and spatter.
   1. Remove and grind smooth excessive weld material and weld spatter on metal surfaces before blast cleaning in accordance with NACE SP0178, Appendix C, Level C.
   2. Grind sharp edges on metal substrate to approximately 1/16-inch radius before abrasive blast cleaning.

B. Prepare metallic surfaces in accordance with applicable portions of surface preparation specifications of the SSPC specified for each coating system.
   1. Remove grease and oil in accordance with SSPC-SP 1.
   2. Use solvent as recommended by the CSM.
   3. Measure profile depth of the surface to be coated in accordance with Method C of ASTM D4417. Select blast particle size and gradation to produce the specified surface profile.
   4. Constantly monitor and maintain ambient environmental conditions to ensure cleanliness and that no "rust back" occurs before coating material application.

C. Prepare metallic surfaces by blast cleaning in accordance with SSPC-VIS 1 (ASTM D2200). Prepare abrasive blast representative areas for the Owner's representative to inspect on the first day of cleaning.

D. Unless otherwise specified, the requirements for blast cleaning steel, ductile iron, and stainless steel substrates are as follows:
   1. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC-SP 10 unless blasting may damage adjacent surfaces, is prohibited, or is specified otherwise. Where abrasive blasting is not possible, clean surfaces to bare metal with power tools in accordance with SSPC-SP 11.
   2. Ferrous metal surfaces to be submerged: Abrasive blast in accordance with SSPC-SP 5, unless specified otherwise, to clean and provide roughened surface profile with a depth between 2 and 4 mils.
   3. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products, or embedded abrasive from substrate before coating application.
   4. When abrasive blasted surfaces rust or discolor before coating, abrasive blast clean surfaces again.

E. Field preparation of shop-primed surfaces:
   1. Smooth welds and prominences with power tools before applying field-applied coatings.
   2. Clean and dry shop-primed ferrous metal surfaces and fabricated assemblies before applying field coats.
   3. Prepare shop epoxy primed surfaces with light abrasive blasting or abrading and then vacuum before applying finish coats.
      a. Follow CSM instructions for surface preparation when the primer recoat limit has been exceeded.
   4. Non-immersion service: Clean in accordance with SSPC-SP 2 (Hand Tool Cleaning) or SSPC-SP 3 (Power Tool Cleaning) and uniformly roughen.
   5. Immersion, BSC, and SC service: Remove shop primer in accordance with SSPC-SP 5 (Near-White Blast Cleaning).

F. Damaged shop primer or rust bleeding:
   1. Ferrous metals: Clean in accordance with SSPC-SP 1 (Solvent Cleaning) and spot blast in accordance with SSPC-SP 10 (Near-White Metal Blast Cleaning) to achieve a uniform surface profile between 2.0 and 2.5 mils before recoating.
   2. Reject galvanized steel with rust bleeding.

G. Damaged coating: Repair by abrasive blast cleaning surfaces as specified for the coating system; feather to a smooth transition before touching up.

3.08 PREPARATION REQUIREMENTS BY SURFACE TYPE

A. Galvanized steel and non-ferrous metal surfaces:
   1. Degrease or solvent clean (SSPC-SP 1) to remove oily residue.
   2. Abrasive blast clean in accordance with SSPC-SP 16.
      a. If abrasive blast cannot be performed, abrade in accordance with SSPC-SP 3 (Power Tool Cleaning).
   3. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded, such as bolts, nuts, or preformed channels.
   4. Test surface for contaminants using copper sulfate solution.

B. Stainless-steel surfaces:
   1. Abrasive blast clean in accordance with SSPC-SP 16 to leave a clean, uniform appearance with surface profile between 1.5 and 2.5 mils.

C. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.

D. Sherardized, aluminum, copper, and bronze surfaces:
   1. Abrasive blast clean in accordance with SSPC-SP 16.
   2. Prepare in accordance with CSM's instructions.

E. Cadmium-plated, zinc-plated, or sherardized fasteners:
   1. Abrasive blast in the same manner as uncoated metal when assembling equipment designated for abrasive blasting.

F. PVC and FRP surfaces:
   1. Lightly sand surfaces to be coated.
      a. Sand to remove gloss and establish uniform surface profile.
   2. Vacuum to remove loose dust, dirt, and other materials.
   3. Solvent clean with clean white rags and allow solvent to evaporate completely before applying coating materials.

3.09 APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Empty aboveground piping to be coated of contents when applying coatings.

C. Mechanical equipment shop primed by the manufacturer.
   1. Pumps and valves: Shop coat with manufacturer's highest quality coating system meeting the project specifications.
      a. Provide CTR shop coating reports.
   2. Non-immersed equipment: Touch up shop primer, and coat in the field with specified coating system after installation.
      a. If project requires equipment removal and reinstallation, complete touch-up coating after final installation.
   3. Immersed equipment not shop coated: Remove shop primer before surface preparation and field apply coating.

D. Verify surface preparation immediately before applying coating in accordance with SSPC-SP COM and the SSPC visual standard for the specified surface preparation method.

E. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

F. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.

G. Do not apply coatings to a surface until it has been prepared as specified.

H. Use equipment designed to apply materials specified.
    1. Use compressors with moisture traps and filters that remove water and oils from the air.
        a. Perform a paper blotter test at the Engineer's request to verify air is sufficiently free of oil and moisture. Do not allow the amount of oil and moisture to exceed CSM-recommended amount.
    2. Equip spray equipment with properly sized mechanical agitators, pressure gauges, pressure regulators, and spray nozzles.

I. Where 2 or more coats are required, tint prime coat intermediate coats as necessary to distinguish each coating and to help indicate coverage.
    1. Do not use color additives with chromium, lead or lead compounds that hydrogen sulfide, other corrosive gases, might destroy or alter. Apply the specified number of coats.

J. Apply coating by brush, roller, trowel, or spray unless a specific application method is required by coating manufacturer's instructions or these Specifications.
    1. Apply primer or first coat by brush to power tool cleaned ferrous surfaces.
    2. Brush or spray-apply coats for blast-cleaned ferrous surfaces and subsequent coats for non-blast cleaned ferrous surfaces.
    3. After prime coat dries, mark, repair, and retest pinholes and holidays before intermediate or top coats are applied.

K. Spray application:
    1. With a brush, stripe coat edges, welds, corners, nuts, bolts, and difficult-to-reach areas, as necessary, before spray application to ensure specified coating thickness along edges.
    2. When using spray application, apply each coat to thickness no greater than recommended in coating manufacturer's instructions.
    3. Use airless spray method unless air spray method is required by CSM's instruction or these Specifications.
    4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.

L. Lightly sand and thoroughly clean surfaces to receive high-gloss finishes unless CSM instructs otherwise.

M. Remove dust on coatings between coats.

N. Shop and field coats:
    1. Prime coat: Shop-apply or field-apply prime coats as specified. Use shop-applied primer compatible with the specified field coating system and apply at the minimum dry film thickness recommended by the finish coat CSM.
        a. Provide datasheets identifying the shop primer to on-site coating application personnel.
        b. Perform adhesion tests on the shop primer.
        c. Remove and recoat damaged, deteriorated, and poorly applied shop coatings.
        d. If shop primer coat meets this Section's requirements, spot prime exposed metal of shop-primed surfaces before spray applying primer over the entire surface.

2. Field coats: Apply field coats with 1 or more prime coats and finish coats to build up coating to dry film thickness specified for the coating system.
    a. Do not apply finish coats until other work in the area is complete and previous coats are inspected.
3. Adhesion confirmation: Perform adhesion tests after proper coating cure in accordance with ASTM D3359. Demonstrate that:
    a. Prime coat adheres to the substrate.
    b. Coatings adhere to the prime and intermediate coats.
        1) Coating 5 mils or more DFT: Achieve adhesion test result of 5A on immersed surfaces and 4A or better on other surfaces.
        2) Coating less than 5 mils DFT: Achieve adhesion test results of 5B on immersed surfaces and 4B or better on other surfaces.

O. Brush, roll, trowel, or spray and back roll coats for concrete and masonry.

P. Plural component coating application:
1. Premix contents of component drums if required by the CSM each day.
2. Before starting application:
    a. Verify gauges are working properly.
    b. Complete ratio checks.
    c. Sample the mix on plastic sheeting to ensure set time is appropriate and complete.
    d. Label and retain spray samples. Submit to Engineer when requested.

Q. Drying and recoating:
1. Provide fans, heating devices, or other means to prevent condensate or dew on substrate surface or between coats and during curing after applying the last coat.
2. Allow each coat to cure or dry thoroughly, in accordance with if required in CSM's printed instructions, before recoating.
3. Use CSM's printed instructions and the requirements specified in this Section to determine minimum required drying time.
    a. Do not allow excessive drying time or exposure, which may impair bond between coats.
    b. Recoat coatings within time limits recommended by CSM.
    c. If time limits are exceeded, abrasive blast clean and de-gloss clean before applying another coat.
4. If limitations on time between abrasive blasting and coating are not met before attaching components to surfaces that cannot be abrasive blasted, coat components before attachment.
5. Ensure primer and intermediate coats of coating are unscarred and completely integral when applying each succeeding coat.
6. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
7. Leave no holidays. Repair holidays in accordance with the requirements on pertinent Coating Detail Sheets or as recommended by the CSM.
8. Sand and feather into a smooth transition and recoat scratched, contaminated, or otherwise damaged coating surfaces so repairs are invisible to the naked eye.
9. For submerged service or highly corrosive headspace service, provide a letter to the Engineer stating that the lining system is fully cured and ready to be placed into service.

R. Workmanship:
   1. Ensure that coated surfaces are free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce a smooth, even film of uniform thickness completely coating corners and crevices.
   2. Coat surfaces without drops, overspray, dry spray, excessive runs, ridges, waves, holidays, laps, or brush marks.
   3. Remove splatter and droppings after coating work is completed.
   4. Evenly apply each coat of material and sharply cut to a line created with masking tape or other suitable materials.
   5. Avoid over spraying or spattering paint on surfaces not to be coated. Protect glass, hardware, floors, roofs, vehicles, and other adjacent areas and installations by taping, drop cloths, or other suitable measures.
   6. When coating complex steel shapes, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer before overall coating system application.
      a. Brush apply stripe coat to ensure proper coverage.
      b. Do not stripe coat with spray or roller.
   7. Ensure that finish coat, including repairs, has a uniform color and gloss.

S. Coating properties, mixing, and thinning:
   1. Thin prime coat and apply as recommended by the CSM. Thinned coating must comply with prevailing air pollution control regulations.
   2. If maximum recoat time is exceeded, prepare surface with solvent washing, light abrasive blasting, or other procedures in accordance with CSM’s instructions.
   3. Allow adequate drying time between coats as instructed by the CSM, adjusted as necessary for the site conditions.
   4. Ensure that coatings, when applied, provide a satisfactory film and a smooth even surface. Lightly sand glossy undercoats to provide a surface suitable for proper application and adhesion of subsequent coats. Thoroughly stir and strain coating materials during application and maintain uniform consistency.
   5. Mix coatings with 2 or more components in accordance with CSM’s instructions.
   6. Where necessary to suit conditions of the surface, temperature, weather, and method of application, thin the coating in accordance with CSM's recommendations.
      a. Ensure that volatile organic content (VOC) of the thinned coating complies with prevailing air pollution control regulations.
      b. Thin coatings to only what is necessary to obtain proper application characteristics.
      c. Use a thinner recommended by the CSM.

T. Film thickness and continuity:
   1. Apply coating to the specified thicknesses.
      a. Apply additional coats when necessary to achieve specified thicknesses, especially at edges and corners.
   2. Verify WFT of the coating system first coat and after applying each subsequent coat.
   3. Do not allow the minimum thickness at any point to deviate more than 25 percent from the required average.

4. Do not allow the surface area covered per gallon of coating for various types of surfaces to exceed those recommended by the CSM.
    a. Provide coating coverage worksheets listing the maximum and minimum coverage for each unit volume of coating for concrete surfaces.
5. Apply additional coats to achieve the specified dry film thickness if brush or roller application methods cannot achieve the specified film thicknesses per coat.

U. Protecting coated surfaces:
1. Do not handle, work on, or otherwise disturb coated items until the coating is completely dry and hard.
2. After installation, recoat shop-coated surfaces with specified coating system as necessary to match surrounding surfaces, and to coordinate with the specified color identification requirements.

V. Special requirements:
1. Before erection, apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces inaccessible after assembly. Apply final coat after erection.
2. Coat structural slip-critical connections and high strength bolts and nuts after erection.
3. Areas damaged during erection:
    a. Prepare surface for spot repairs as specified for the coating system.
    b. Recoat with prime coat before applying subsequent coats.
    c. Touch up surfaces after installation.
    d. Clean and dry surfaces to be coated at time of application.
4. Coat underside of equipment bases and supports not galvanized with at least 2 coats of primer specified before setting the equipment in place.
5. Coat aluminum in contact with concrete.

3.10 APPLICATION REQUIREMENTS FOR CONCRETE COATING SYSTEMS

A. Apply filler/surfacer as recommended by CSM to fill bug holes and air voids in concrete or block texture in CMU, leaving a uniformly filled surface that does not produce blowholes or outgassing causing the coating system to pinhole.
1. Allow filler/surfacers to cure sufficiently before applying prime coat as required by the CSM. Use the CSM-recommended drying time between coats.

B. Apply surfacer or filler and let dry before coating application.
1. Use the drying time between filler/surfacer and coating system specified by the CSM for the site conditions.
    a. Let concrete substrate dry before applying filler/surfacers or coating system materials.
2. If the maximum recoat time is exceeded, prepare surfaces by solvent washing, light abrasive blasting, and other procedures in accordance with CSM's instructions.
3. Apply a complete parge coat of the specified filler/surfacer material over the entire substrate before applying the coating system.
    a. Scrub filler/surfacer into the substrate to completely fill open air voids and bug holes.

b. Completely cover the substrate, unless otherwise specified, above such filled voids by 1/8 inch of thickness.
c. Provide relatively flat, uniformly even surface before coating application.

4. Secondary containment: Place surfacer or filler 1/16-inch thick above concrete plane to create a monolithic surface free of pinholes.
   a. Floor surfaces: Broadcast with aggregate to create a non-slip surface texture.
   b. Remove excess aggregates and apply base coat to encapsulate embedded non-slip aggregate.

C. Concrete substrate temperatures:
   1. Apply filler/surfacers and the coating system when temperatures are falling, typically late afternoon or evening.
      a. Do not coat concrete with rising concrete substrate surface temperatures or substrates in direct sunlight, to minimize outgassing from the substrate and formation of pinholes, and/or blistering.
   2. Should bubbles, pinholes, or other discontinuities form in the applied coating system material, they shall be repaired.
      a. Should discontinuities develop in the filler/surfacer material or in the first coat of the coating material, repair them before the next coat.
      b. When discontinuities occur, open the air void behind or beneath the discontinuities and completely fill with specified coating material. Then, abrade the coated area around the discontinuities repair reapply coating over that area.

D. Perform application detail work in accordance with these Specifications, the CSM's current written recommendations, and Drawings, whichever is stricter.

E. Concrete coating systems application requirements:
   1. Concrete coating minimum dry film thickness excludes parge coat, block filler, and sealer.

3.11 COATING SYSTEM SCHEDULE

A. Attachment A - Schedule of Surfaces to be Coated specifies surfaces to be coated in the field with the coating systems required.

3.12 SURFACES NOT REQUIRING COATING

A. Stainless steel piping, valves, pipe supports, instrument sunshades.

B. Sliding surfaces on expansion joints, motor and pump shafts, machined surfaces at bearings and seals, grease fittings, etc.

C. Galvanized structural steel framing, galvanized roof decking, galvanized pipe supports.

D. Copper and brass pipe, fittings, valves, etc.

E. Bronze valves, bearings, bushings, and fasteners.

F. Corrosion resistant special alloys: Inconel, Alloy 20, Hastelloy, etc.

G. Exterior concrete.

H. Plastic surfaces except coat PVC, CPVC, and other plastic piping system exposed to sunlight.

I. Buried piping that is encased in concrete or cement mortar.

3.13 QUALITY CONTROL

A. Owner-provided inspection or inspection by others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Owner inspection is in addition to any inspection required of the Contractor.

B. Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section. These inspections may include the following:
   1. Inspect materials upon receipt to ensure that the CSM supplied them.
   2. Verify that specified storage conditions for the coating system materials, solvents, and abrasives are provided.
   3. Inspect and record findings for substrate cleanliness.
   4. Inspect and record pH of concrete and metal substrates.
   5. Inspect and record substrate profile (anchor pattern).
   6. Measure and record ambient air and substrate temperature.
   7. Measure and record relative humidity.
   8. Check for substrate moisture in concrete.
   9. Verify that mixing of coating system materials is in accordance with CSM's instructions.
   10. Inspect, confirm, and record that coating system materials' "pot life" is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
   11. Perform adhesion testing.
   12. Measure and record the coating system's thickness.
   13. Verify proper curing of the coating system in accordance with the CSM's instructions.
   14. Holiday or continuity testing in accordance with NACE SP0188 for coatings that will be immersed or exposed to aggressively corrosive conditions.

C. Perform holiday testing in accordance with NACE SP0188 to identify holidays or pinholes needing repair for coating over 100 percent of surfaces:
   1. Coated steel that will be immersed or exposed to aggressively corrosive conditions.
   2. Coated concrete.
   3. Perform holiday tests after proper application and coating system cure.

3.14 CORRECTIVE MEASURES

A. Repair pinholes or holidays identified by Holiday Testing as follows:
   1. Remove the coating system with a grinder or other suitable power tool.

2. Remove coating system at pinholes and holidays at least 2 inches diameter around the defect back to expose substrate.
3. Concrete voids: Chip back to expose entire cavity in all directions.
    a. Completely fill void with approved filler/surfacer material using a putty knife or other suitable tool and strike off. Cure in accordance with CSM's recommendations.
4. Aggressively abrade or sand the intact coating system surface at least 3 inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
5. Vacuum the prepared area to remove dust, dirt, etc., leaving clean, sound surfaces.
6. Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
7. Apply the coating system with enough coats to achieve the specified finish coat thickness over the defect and coating removal area. Feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline.
8. Follow curing time between coats as specified by CSM for the site conditions. Solvent wash and abrasive blast in accordance with CSM's instructions if the maximum recoat time is exceeded.
9. Apply coating at specified dry film thickness.

3.15 CLEANUP

A. Remove surplus materials, protective coverings, and accumulated rubbish after completing coating. Thoroughly clean surfaces and repair overspray or other coating-related damage.

3.16 FINAL INSPECTION

A. Conduct final inspection of coating system work to determine whether it meets specifications requirements.

B. Conduct subsequent final inspection with the Engineer to ensure Work is in accordance with Contract Documents requirements.

C. Mark any rework required.
    1. Re-clean and repair, as specified, at no additional cost to the Owner.

END OF SECTION

ATTACHMENT A - SCHEDULE OF SURFACES TO BE COATED

ATTACHMENT A
Schedule of Surfaces to be Coated

A. The following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Contact Engineer for clarification.

EPU-M-1	Metals, exterior, non-immersed
EPX-M-2	Metals, interior, non-immersed; piping within sludge storage tanks, pumps, and interior walls of area 420.
EPX-M-5	Aluminum surfaces in contact with concrete or masonry. Locations where Alkali-resistant bitumastic is specified.
EPX-C-6-BSC	Area 440 Sludge Storage Tank interior including walls and underside of top slab.
ACR-PVC-1	PVC pipe and FRP duct

Notes:

1: Non-immersed ferrous metal surfaces include:
- a. Doors, doorframes, ventilators, louvers, grilles, exposed sheet metal, and flashing.
- b. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
- c. Motors and motor accessory equipment.
- d. Drive gear, drive housing, coupling housings, and miscellaneous gear drive equipment.
- e. Valve and gate operators and stands.
- f. Structural steel.
- g. Crane and hoist rails.
- h. Exterior of tanks and other containment vessels.
- i. Mechanical equipment supports, drive units, and accessories.
- j. Bare electrical equipment: boxes, exposed conduit, and accessories.
- k. Pumps not submerged.
- l. Other miscellaneous metals.

2: Immersed ferrous metal surfaces include:
- a. Interior surfaces of ferrous metal tanks.
- b. Field priming of ferrous metal surfaces with defective shop-prime coat; including non-submerged service.
- c. Bell rings, underside of manhole covers and frames.
- d. Sump pumps, including underside of base plates and submerged suction and discharge piping.
- e. Exterior of submerged piping and valves other than stainless steel or PVC piping.
- f. Submerged pipe supports and hangers.
- g. Stem guides.
- h. Other submerged iron and steel metal unless specified otherwise.

ATTACHMENT B - COATING DETAIL SHEETS

Attachment B			
Coating Detail Sheet			
Coating System	EPU-M-1		
Coating Material	Two coats epoxy with polyurethane finish coat		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carbothane 134 VOC
International Paint	Devran 224V	Devran 224V	Devthane 379
PPG	Amercoat 385	Amercoat 385	Amercoat 450H
Sherwin Williams	Macropoxy 646	Macropoxy 646	Hi Solids Polyurethane
Tnemec	Series 69	Series 69	Series 1095
Service Condition	Interior or Exterior, subject to direct sunlight. Non-immersion.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP10, Near-White Blast Cleaning. Shop primed surfaces: SSPC-SP2, Hand Tool Cleaning or SSPC-SP3, Power Tool Cleaning. Damaged primer or rust: SSPC-SP10, Near White Blast Cleaning and spot prime.		
Nonferrous Metal	SSPC-SP16, Brush Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush Blast Cleaning. Test for surface contaminants.		
Surface Profile			
Ferrous Metal	2.5 to 3.0 mils		
Nonferrous Metal	1.5 to 2.0 mils		
Galvanized Metal	1.5 to 2.0 mils		
System Thickness (Dry Film)			
Total	10 to 13 mils		
Primer	4 to 5 mils		
Intermediate Coat	4 to 5 mils		
Finish Coat	2 to 3 mils		
Application			
Special CTR Training	Not required.		

Attachment B			
Coating Detail Sheet			
Coating System	EPX-M-2		
Coating Material	Epoxy		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carboguard 890
International Paint	Bar-Rust 236	Bar-Rust 236	Bar-Rust 236
PPG	Amerlock 2/400 Series	Amerlock 2/400 Series	Amerlock 2/400 Series
Sherwin Williams	Tank Clad HS	Tank Clad HS	Tank Clad HS
Tnemec	Series 69	Series 69	Series 69
Service Condition	Immersed, non-immersed, moderately corrosive environment.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP5, White Metal Blast Cleaning. Shop primed surfaces: SSPC-SP7, Brush-Off Blast Cleaning. Damaged primer or rust: SSPC-SP5, White Metal Blast Cleaning and spot prime.		
Nonferrous Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Surface Profile			
Ferrous Metal	2 to 4 mils		
Nonferrous Metal	1.0 to 1.5 mils		
Galvanized Metal	1.0 to 1.5 mils		
System Thickness (Dry Film)			
Total	12 to 16 mils		
Primer	4 to 6 mils		
Intermediate Coat	4 to 6 mils		
Finish Coat	4 to 6 mils		
Application			
Special CTR Training	Not required.		

Attachment B			
Coating Detail Sheet			
Coating System	EPX-M-5		
Coating Material	Epoxy mastic		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	CSM recommended	None applied	Carbomastic 15
International Paint	CSM recommended	Bar-Rust 231	Bar-Rust 231
PPG	CSM recommended	None applied	Amerlock 2 AL
Sherwin Williams	CSM recommended	None applied	Epoxy Mastic Aluminum II
Tnemec	CSM recommended	Series 135	Series 135
Service Condition	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP11, Power to Cleaning to Bare Metal. Shop primed surfaces: SSPC-SP3, Power Tool Cleaning. Damaged primer or rust: SSPC-SP11, Power to Cleaning to Bare Metal.		
Nonferrous Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Surface Profile			
Ferrous Metal	2.0 to 2.5 mils		
Nonferrous Metal	1.0 to 1.5 mils		
System Thickness (Dry Film)			
Total	15 to 19 mils		
Primer	2 to 4 mils		
Finish Coat	15 mils		
Application			
Special CTR Training	Not required.		

Attachment B			
Coating Detail Sheet			
Coating System	EPX-C-6-BSC		
Coating Material	Blended Amine Cured Epoxy		
Substrate	Concrete		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Plasite 5371	Plasite 4500S	Plasite 4500S
International Paint	Enviroline 222	Enviroline 222	Enviroline 222
Neopoxy	NPR-5305	NPR-5300	NPR-5300
Sauereisen	Sewergard 210T	Sewergard 210G	Sewergard 210G
Sherwin Williams	Duraplate 6100 filled	Duraplate 6100	Duraplate 6100
Tnemec	Series 434	Series 435	Series 435
Service Condition	Immersed, non-potable; non-immersed, corrosive environment, biogenic sulfide corrosion, new or existing construction. Waterproofing in accordance with 07900(07_10_00) - Joint Sealants for exterior of buried tanks.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Concrete	Apply concrete surfacer, as required, after surface preparation is accepted to provide a smooth surface. Completely fill all bugholes with the same material. Brush blast clean after adequate cure per CSM's instructions to produce a uniform anchor pattern. Let concrete substrate cure under warm conditions (minimum of 75 degrees F) for at least 5 days before coating application if using wet abrasive or water jet surface preparation. Sawcut 1/4" minimum deep groove and provide coating termination and transition details as shown on the drawings and in accordance with CSM's standard details including terminations, transitions at corners, cracks, pipe penetrations, terminations at metal embedments, and other details. Vacuum all surfaces to be coated after surface preparation and curing to remove all loose dirt, dust, or other loose materials.		
Existing Concrete	Prepare as for new concrete. Apply a filler material and coat with surfacer to restore the substrate to a smooth surface suitable for coating. Refer to Section 09968(09_96_08) - Concrete Repair and Coating		
Surface Profile			
Concrete	ICRI CSP 5.		
Existing Coated Concrete	ICRI CSP 5.		
System Thickness (Dry Film)			
Surfacer	Completely cover the substrate above filled voids by 1/8 inch (125 mils) of thickness.		
Total	60 mils dry film in addition to the parge coat.		
Primer	One coat at CSM's recommended dry film thickness.		
Intermediate and Finish Coats	Each coat at CSM's recommended DFT to specified system thickness.		
Application			
Special CTR Training	Required.		

Attachment B			
Coating Detail Sheet			
Coating System	ACR-PVC-1		
Coating Material	Acrylic		
Substrate	PVC and CPVC pipe		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carbocrylic 120	None Applied	Carbocrylic 3359
International Paint	Devcryl 1440	None Applied	Devcryl 1448
PPG	Pitt Tech Primer	None Applied	Pitt Tech
Sherwin Williams	Sher Cryl HPA	None Applied	Sher Cryl HPA
Tnemec	Series 1028 or 1029	None Applied	Series 1028 or 1029
Service Condition	Exterior, exposed to direct sunlight, non-immersed.		
Surface Preparation	Prepare surfaces as specified in this Section and as follows.		
General	Clean to remove loose dirt, dust, or other contaminants. Sand surfaces to achieve a uniform, roughened surface profile. Solvent clean and vacuum to remove loose debris.		
Surface Profile	1.5 to 2.0 mils		
System Thickness (Dry Film)			
Total	4 to 8 mils		
Primer	2 to 4 mils		
Finish Coat	2 to 4 mils		
Application			
Special CTR Training	Not required.		

SECTION 10_14_00

SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Plastic and metal signs for building and Site use.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Z535.1 - Safety Colors.
   2. Z535.2 - Environmental and Facility Safety Signs.

B. National Fire Protection Association (NFPA):
   1. 704 - Standard System for the Identification of the Hazards of Materials for Emergency Response.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Manufacturer’s data indicating sign type, style, and color.

C. Shop Drawings:
   1. Include lists of sign types, sizes, text, colors, and locations.

D. Samples: Include actual materials.

E. Manufacturer’s installation instructions.

1.04 QUALITY ASSURANCE

A. Regulatory requirements: Provide signage in accordance with Americans with Disabilities Act as published in the Federal Register, Volume 56, No. 144, Friday, July 26, 1991.

PART 2 PRODUCTS

2.01 ROOM AND AREA SIGNS

A. Manufacturers:
   1. One of the following or equal:
      a. Andco Industries Corp., equivalent product.
      b. Best Manufacturing Sign Systems, System 900013.
      c. Vomar Products, Inc., equivalent product.

B. Attachment:
   1. Vinyl tape, self-adhering.

C. Lettering:
   1. Helvetica medium, 3/4 inch high.

D. Materials:
   1. Interior use:
      a. Plastic 1/8-inch thick raised letters.
   2. Exterior use:
      a. Fiberglass 1/4 inch thick with high gloss finish, raised letters, blasted from single piece of fiberglass for integral letter and background.
      b. No adhesive as mechanical fastening of letters shall be allowed.

E. Colors:
   1. As selected by the Engineer from the manufacturer’s standard colors.

F. See Attachment A - Room and Area Signage Schedule for specific sign size, location, text, pictogram, and quantity.

2.02 SAFETY SIGNS

A. General:
   1. Colors: In accordance with ANSI Z535.1.
   2. Design: In accordance with ANSI Z535.2.
   3. 40-mil thick aluminum with baked enamel finish.
   4. Fasteners: Round head stainless steel bolts or screws.

B. Manufacturers: One of the following or equal:
   1. Emedco.
   2. Seton Name Plate Co., Special Wording.

C. Danger signs:
   1. Background: White.
   2. Heading: White lettering on red oval with white border in black rectangular panel.
   3. Message: Black lettering on white.
   4. Size: As scheduled.

D. Caution signs:
   1. Background: Yellow.
   2. Heading: Yellow lettering on black rectangular panel.
   3. Message: Black lettering on yellow.
   4. Size: As scheduled.

E. Safety instruction signs:
   1. Background: White.
   2. Heading: White lettering on green rectangular panel.
   3. Message: Black lettering.
   4. Size: As scheduled.

F. Warning signs:
   1. Background: Orange.
   2. Heading: Black lettering on orange diamond in black rectangular panel.
   3. Message: Flack lettering on orange.
   4. Size: As scheduled.

G. Notice information signs:
   1. Background: White.
   2. Heading: White lettering on blue rectangular panel.
   3. Message: Black lettering.
   4. Size: As scheduled.

H. See Attachment B - Safety Signage Schedule for specific sign size, location, text, and quantity.

2.03 CAST ALUMINUM LETTERS

A. Manufacturers:
   1. One of the following or equal:
      a. Metal Arts.
      b. OMC Industries.
      c. Southwell Co.

B. Material:
   1. Cast aluminum.

C. Text size and font:
   1. Text size and font: Match existing.
   2. Text content: As indicated in schedule (Building identification only).

D. Finish:
   1. Black Duranodic coating.

E. Mounting:
   1. Projected jamb nut mounting, concealed.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect adjacent surfaces which may be damaged by installation of signs.

B. Prepare substrates in accordance with the sign manufacturer’s instructions.

C. Remove scale, dirt, grease, and other contaminates from substrates.

3.02 INSTALLATION

A. Install signs in accordance with the sign manufacturer’s instructions.

B. Fasten signs securely in level, plumb, and true to plane positions.

C. Install signs where indicated by Engineer in lieu of scheduled location.

END OF SECTION

ATTACHMENT A - ROOM AND AREA SIGNAGE SCHEDULE

ROOM AND AREA SCHEDULE

A. Building Numbers: Area 420 – Sludge Storage Building
   1. Location: On wall outside building in location specified by the Engineer.
   2. Height: As selected by the Engineer.
   3. Size: Cast Aluminum Letters.
   4. Colors: As selected by the Engineer.
   5. Text: Area 440 – Sludge Storage Tanks.

B. Room Numbers: Area 420 – Sludge Storage Building
   1. Location: On wall outside room adjacent to latch side of doors or when not enough space on latch side, on nearest adjacent wall.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square.
   4. Colors: As selected by the Engineer.
   5. Text: Room number as indicated on the Drawings. Signage of following rooms: Electrical Room, Storage Room, Pump Room.

C. Building Numbers: Area 440 – Sludge Storage Tanks
   1. Location: On wall outside tanks in location specified by the Engineer.
   2. Height: As selected by the Engineer.
   3. Size: Cast Aluminum Letters.
   4. Colors: As selected by the Engineer.
   5. Text: Area 440 – Sludge Storage Tanks.

D. Stair Doors:
   1. Location: On wall outside room adjacent to latch side of doors or when not enough space on latch side, on nearest adjacent wall.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square.
   4. Colors: As selected by the Engineer.
   5. Pictogram: Means of egress indication.

ATTACHMENT B - SAFETY SIGNAGE SCHEDULE

SAFETY SIGNAGE SCHEDULE

E. NON-POTABLE WATER:
   1. Location: At non-potable water hose valves (W3, W2).
   2. Height: Within 12-inches of hose valve.
   3. Size: 10 inches wide by 7 inches high.
   4. Heading: DANGER
   5. Wording: NON-POTABLE WATER
      DO NOT DRINK

F. REMOTELY CONTROLLED AUTOMATIC EQUIPMENT:
   1. Location: On front and back of equipment (pumps, mixers, and fans) that starts automatically by remote control.
   2. Height: As selected by Engineer.
   3. Size: 14 inches wide by 10 inches high.
   4. Heading: DANGER
   5. Wording: THIS EQUIPMENT STARTS AUTOMATICALLY
      BY REMOTE CONTROL

G. HIGH VOLTAGE WARNING:
   1. Location: On front and back of equipment, adjacent to doors to rooms containing devices that operate at 600 volts or greater.
   2. Height: 60 inches above floor to center of the sign.
   3. Size: 14 inches wide by 10 inches high.
   4. Heading: DANGER
   5. Wording: HIGH VOLTAGE
      KEEP OUT

H. NO SMOKING INFORMATIONAL SIGNS:
   1. Location: On exterior face of walls for Area 420, and 440, adjacent to each entry point (exterior door) to all buildings.
   2. Height: 60 inches above floor to center of sign. Where metal safety signs are also located adjacent to entry points, place no smoking signs below these signs.
   3. Size: 6 inches square.
   4. Heading: None.
   5. Wording: None.
   6. Pictogram: International “No Smoking” symbol.

SECTION 10_44_00

FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fire extinguishers.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E814-11a - Standard Test Method for Fire Tests of Penetration Firestop Systems.

B. National Fire Protection Association (NFPA):
   1. 10 - Standard for Portable Fire Extinguishers.

C. Underwriters Laboratories, Inc. (UL):
   1. 711 - Rating and Fire Testing of Fire Extinguishers.

1.03 SUBMITTALS

A. Product data.
   1. Extinguishers: Materials description for fire extinguishers; include ratings and classifications.
   2. Installation instructions for each product specified.

B. Shop drawings:
   1. Small-scale plans showing locations of individual fire extinguishers.
   2. Indicate installation procedures and accessories required for a complete installation.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Minimum 5 years with satisfactory performance record.

1.05 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following or equal:
   1. Activar Construction Products Group – JL Industries.

2.02 FIRE EXTINGUISHERS

A. Multi-purpose chemical type:
   1. Extinguisher unit containing a fluidized and siliconized mono ammonium phosphate powder; nonconductive and nontoxic.
   2. Construction: Heavy duty steel cylinder with metal valve and siphon tube, o-ring seal, replaceable valve stem seal, visual pressure gage, pull pin and upright squeeze grip.
   3. Finish: Factory powder-coated: Red.
   4. UL Effectiveness Rating in accordance with UL 711: Class A, B, and C fires.
   5. UL Rating in accordance with UL 711: 10A-120BC.
   6. Drawing will use the symbol FE for “Fire Extinguisher”.

B. Regular dry chemical type:
   1. Extinguisher unit containing Halotron™.
   2. Size minimum: 11 pounds.
   3. Construction: Heavy duty steel cylinder with metal valve and siphon tube, o-ring seal, replaceable valve stem seal, visual pressure gage, pull pin, and upright squeeze grip.
   4. Finish: Factory powder-coated; Red.
   5. UL Effectiveness Rating in accordance with UL 711: Class B and C fires.
   6. UL Rating in accordance with UL 711: 2A-10BC.
   7. Drawing will use the symbol EFE for “Electrical Fire Extinguisher”.

2.03 WALL BRACKETS

A. Type: Standard as manufactured by fire extinguisher manufacturer.

2.04 EXTRA MATERIALS

A. Furnish a minimum 10 percent, but not less than 1, of fire extinguishers with brackets installed in addition to the number indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance NFPA 10, Standard for Portable Fire Extinguishers.

3.02 LOCATIONS

A. Install fire extinguisher type, FE and EFE, as indicated on the Drawings.

B. Install fire extinguisher wall brackets as indicated on the Drawings.

END OF SECTION

SECTION 22_42_01

PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for materials and installation of plumbing systems.

1.02 REFERENCES

A. Abbreviations:
   1. gph - gallons per hour.
   2. gpm - gallons per minute.
   3. psig - pounds per square inch, gauge.

B. Standards:
   1. American Gas Association (AGA).
   2. American Society of Mechanical Engineers (ASME).
      a. B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
      b. B16.12 - Cast Iron Threaded Drainage Fittings.
   3. American Society of Sanitary Engineering (ASSE):
      a. 1070 - Performance Requirements for Water Temperature Limiting Devices.
   4. American Water Works Association (AWWA):
      a. C511 - Reduced-Pressure Principle Backflow Prevention.
      b. C700 - Standard for Cold-Water Meters—Displacement Type, Bronze Main Case.
      c. C702 - Standard for Cold-Water Meters—Compound Type.
   5. Americans with Disabilities Act (ADA).
   6. ASTM International (ASTM):
      a. A48 - Standard Specification for Gray Iron Castings.
      b. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
      d. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      e. A888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
      f. B32 - Standard Specification for Solder Metal.
      g. B88 - Standard Specification for Seamless Copper Water Tube.
      h. B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
      i. B828 - Standard Specification for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

j. C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
k. C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
l. C547 - Standard Specification for Mineral Fiber Pipe Insulation.
m. C552 - Standard Specification for Cellular Glass Thermal Insulation.
n. C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
o. C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
p. D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
q. D297 - Standard Test Methods for Rubber Products—Chemical Analysis.
r. D395 - Standard Test Methods for Rubber Property—Compression Set.
s. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
t. D638 - Standard Test Method for Tensile Properties of Plastics.
u. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
v. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
w. D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
x. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
y. D2240 - Standard Test Method for Rubber Property—Durometer Hardness.
z. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
aa. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
bb. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
cc. D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
dd. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
ee. E96 - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
ff. F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
gg. F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
hh. F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
ii. F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
jj. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

kk. F594 - Standard Specification for Stainless Steel Nuts.
ll. F645 - Standard Guide for Selection, Design, and Installation of Thermoplastic Water- Pressure Piping Systems.

7. International Association of Plumbing and Mechanical Officials (IAPMO):
   a. IS 03 - Copper plumbing Tube Pipe and Fittings.
8. National Electrical Manufacturers Association (NEMA):
   a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
9. Plumbing and Drainage Institute (PDI):
   a. WH-201 - Water Hammer Arresters Standard.
10. Underwriters Laboratories, Inc. (UL):
    a. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
11. United States Environment Protection Agency (EPA): Water Sense.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Buried: Piping that is installed below buildings, foundations, or finish grade, either in soil or encased in concrete in soil.
   2. Exterior: Piping that is installed outside a building or within a pipe trench or tunnel.
   3. Flame spread and smoke density: Burning characteristics determined in accordance with ASTM E84.
   4. Interior: Piping that is installed inside a building.
   5. K factor: Thermal conductivity determined in accordance with ASTM C177 or ASTM C518.
   6. Mineral fiber: Fibers manufactured of glass, rock, or slag processed from a molten state, with or without a binder.
   7. Water vapor permeance: Water vapor transmission determined in accordance with ASTM E96 and expressed in units of perm-inch.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Manufacturer’s instructions.

C. Shop Drawings:
   1. System layout, mechanical, electrical power, and control diagrams.
   2. Nameplate information.
   3. Materials.
   4. Coatings and linings.
   5. Rough-in drawings.
   6. Supports, vibration isolators, and details.
   7. Primary and ancillary equipment.
   8. Proposed cutting and patching.
   9. Maximum recommended equipment vibration levels and field-testing method.
   10. Copy of factory test results.

D. Certificates: As specified in Section 01_60_00 - Product Requirements:
   1. American Backflow Prevention Association for backflow prevention assembly.
   2. National Science Foundation for products when specified.

E. Field testing documentation.

F. Warranties.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Roof coordination:
   1. Provide plumbing equipment roof penetrations information required in the preparation of roofing drawings, including, but not limited to:
      a. Location.
      b. Diameter.
      c. Configuration of penetration and the surround.
   2. Provide roof mounted plumbing equipment information required in the preparation of roofing drawings, including, but not limited to:
      a. Location.
      b. Size.
      c. Weight.
      d. Anchoring and support details.

1.06 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 PLUMBING AND DRAINAGE PRODUCTS

A. Cleanouts:
   1. Cleanouts:
      a. Cast-iron ferrule, countersunk plug, gastight and watertight seal.
      b. Adjustable cleanout head extension.
      c. Nickel-bronze top and securing screw.
      d. Type FCO-3: Floor cleanout, exterior, in asphalt or ground areas:
         1) Manufacturers: One of the following or equal:
            a) Josam Co., 55000.
            b) Zurn Ind., Inc.
         2) Rated for outdoor use.

B. Drains:
   1. Type, shape, and size as indicated on the Drawings with connections suitable for the piping system.
      a. Provide drains of one type from the same manufacturer.
   2. Type FD-1: Floor drain, finished floors, pedestrian traffic:
      a. Manufacturers: One of the following or equal:
         1) Josam, 30000-A.
         2) Zurn.

b. Round, adjustable strainer head, floor level grate.
c. Body material: Coated cast iron.
d. Strainer:
1) Material: Nickel bronze.
2) Size:
a) 6 inch diameter for 3-inch drain.
b) 8 inch diameter for 4-inch drain.

3. Type RD-3: Roof drain, scupper:
a. Manufacturers: One of the following or equal:
1) Josam.
2) Zurn, Z187.
b. Scupper roof drain.
c. Material:
1) Body: Coated cast-iron.
2) Strainer: Coated cast-iron angle.

4. Type RD-4: Roof drain, downspout nozzle:
a. Manufacturers: One of the following or equal:
1) Josam.
2) Zurn, Z199.
b. Downspout nozzle.
c. Material: Nickel-bronze body and wall flange.

2.02 PLUMBING PIPING SYSTEMS

A. As indicated on the Drawings in the Piping Schedule.

B. Cast iron soil pipe piping system:
1. In accordance with ASTM A74.
2. Bell-and-spigot, service weight.
a. Above ground: Hubless in accordance with CISPI 310.
3. Joints underground: Positive double seal compression type gaskets in accordance with ASTM C564.
4. Joints aboveground:
a. American standard taper screw threads, cut clean and made up with Teflon™ tape or an acceptable paste thread compound applied to the male threads only.
b. Slip joints permitted only in trap seals or on the inlet side of the traps.
1) Do not use long screws or bushings.
5. Cast iron drainage pattern fittings.
6. Couplings for “No Hub”: Stainless steel corrugated shield and clamp assembly over a molded 1-piece neoprene sealing sleeve, in accordance with ASTM A888.
7. Line pipe and fittings inside and coat outside with bituminous coating, except as follows:
a. Exposed, above ground piping:
1) Line inside only.
2) Coat outside with EPU-M-1, epoxy polyurethane, as specified in Section 09_96_01 - High-Performance Coatings.
a) Color: Coordinate with the Owner.
8. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

C. Chlorinated polyvinyl chloride (CPVC) piping system:
   1. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material, except where permitted in the referenced standards.
   2. Pipe:
      a. Manufacturers: One of the following or equal:
         1) Charlotte Pipe and Foundry Co.
         2) Chemtrol.
         3) Eslon Thermoplastics, Inc.
         4) GF Harvel.
         5) Spears Manufacturing Co.
      b. In accordance with ASTM F441 and Appendix, CPVC 4120.
      c. Extruded from Type IV, Grade 1, Class 23447 material in accordance with ASTM D1784.
      d. Schedule 80, unless otherwise specified.
   3. Fittings:
      a. As appropriate to the service and pressure requirement.
         1) In accordance with:
            a) ASTM F438 for Schedule 40.
            b) ASTM F439 for Schedule 80.
      b. Same material as the pipe and of equal or greater pressure rating.
      c. Supplied by pipe manufacturer.
   4. Solvent cement:
      a. In accordance with ASTM F493.
      b. Manufacturers: The following or equal:
         1) IPS Corp.
      c. Certified by the manufacturer for the service of the pipe.
      d. Primer: As recommended by the solvent cement manufacturer.
   5. Unions 4 inches and smaller:
      a. Socket end screwed unions.
   6. Unions 6 inches and larger:
      a. Socket flanges with 1/8-inch full-face soft EPDM gasket.

2.03 WALL AND FLOOR SEALS

A. Single seal.

B. Seal element: Nitrile with the following physical characteristics:
   1. ASTM D297 Specific Gravity: 1.15.
   2. ASTM D395 Compression Set (22 hours at 158 degrees Fahrenheit): 45 percent.
   3. ASTM D412 Elongation at Break: 300 percent.
   4. ASTM D412 Tensile Strength: 1,300 psi.
   5. ASTM D2240 Durometer Hardness (Shore A): 50±5.

C. Pressure plate: Reinforced nylon polymer:
   1. ASTM D256 IZOD Impact/Notch: 11.1 ft-lb/in.
   2. ASTM D638 Elongation (Break): 11 percent.
   3. ASTM D638 Tensile Strength (Yield): 20,000 psi.
   4. ASTM D790 Flexural Modulus: 1,124,000 psi.
   5. ASTM D790 Flexural Strength (Yield): 30,750 psi.
   6. ASTM D792 Specific Gravity: 1.38.

D. Bolts: Type 316 stainless steel in accordance with ASTM F593, minimum tensile strength of 85,000 psi.

E. Nuts: Type 316 stainless steel in accordance with ASTM F594, minimum tensile strength of 85,000 psi.

2.04 ANTI-SEIZE LUBRICANT

A. Manufacturers: One of the following or equal:
   1. Bostik, Never Seez.
   2. Oil Research Center.

B. Use with assembly of stainless steel nuts and bolts.

PART 3 EXECUTION

3.01 GENERAL

A. Furnish and install vents required in drainage piping as part of the plumbing system, in accordance with Laws and Regulations.

B. Use anti-seize lubricant for stainless steel treads on fittings and fasteners.

3.02 INSTALLATION

A. Fixtures:
   1. Rough-in fixtures and accessories in accordance with the dimensions supplied by the manufacturers of the fixtures.
   2. Mount fixtures and accessories without cutting of finish surface.

B. Plumbing and drainage products:
   1. Traps:
      a. Install traps as near the fixtures as possible.
   2. Sizes of equipment drains and of floor drains shall be as indicated on the Drawings.

C. Plumbing piping systems:
   1. Cast iron soil pipe, PVC, polypropylene:
      a. Where not specified otherwise, install horizontal piping with a grade of 1/4 inch per foot.
      b. Provide vents, roof drains, and pipes flashed and made watertight at the roof with lead sheet flashings.
         1) Minimum 4-pound lead sheet.
      c. Extend flashing not less than 6 inches up the pipes, and counter flash with standard cast iron or malleable iron recessed roof couplings.
      d. Extend flashing for vents up to the top of the vent and turn down into the pipe.
      e. Extend flashing shields not less than 8 inches from vent and pipe in all directions.

2. Copper tube:
    a. Install in accordance with ASTM B828 and IAPMO IS 03.
    b. Install in straight runs, supported at intervals close enough to avoid sagging.
    c. Make cuts square with a tubing cutter or with a 32-tooth hacksaw.
        1) Provide a sizing tool to correct distortions.
    d. Insulate piping as specified.
3. Black steel:
    a. Install in accordance with applicable codes and regulations.
4. CPVC:
    a. Install in accordance with ASTM F645 or the manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
    b. Provide molded transition fittings for transitions from plastic to metal or IPS pipe.
        1) Do not thread pipe.
        2) Do not use flanged transition fittings unless specifically indicated on the Drawings.
    c. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
    d. Provide serrated nipples for transition from plastic pipe to rubber hose.
    e. Clean dirt and moisture from pipe and fittings.
    f. Bevel pipe ends in accordance with the manufacturer's instructions with chamfering tool or file.
        1) Remove burrs.
    g. Use solvent cement and primer formulated for CPVC.
    h. Use primer on pressure and non-pressure joints.
    i. Do not solvent weld joints when ambient temperatures are below 40 degrees Fahrenheit or above 90 degrees Fahrenheit unless solvent cements specially formulated for these conditions are utilized.

D. Wall and floor seals:
    1. Provide seals at rated walls.
    2. Provide seals between floors.
    3. Use specified barrier seals for concrete/masonry wall and floor penetrations.

E. Anti-seize lubricant:
    1. Use with assembly of stainless steel nuts and bolts.

F. Backflow preventers:
    1. Include shutoff valves at each end of backflow preventer with properly located test cocks.

3.03 FIELD QUALITY CONTROL

A. Test water piping in accordance with the plumbing code as specified in Section 01_41_00 - Regulatory Requirements.

B. Test drain, waste, and vent lines as specified and in accordance with the plumbing code as specified in Section 01_41_00 - Regulatory Requirements.

C. Backflow preventer:
   1. Test witnessing: Witnessed.
   2. Conduct pressure and leak test as specified in Section 40_05_51.01 - Common Work Results for Valves.
   3. Certificate of backflow prevention from a tester listed by the American Backflow Prevention Association.

3.04 CLEANING

A. Upon completion of installation, clean piping interior of foreign matter and debris.

3.05 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

SECTION 23_05_00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. General prescriptive, design, and performance requirements for products and mechanical equipment used to heat, ventilate, cool, or otherwise condition or distribute indoor air.
   2. Specific requirements for ductwork accessories:
      a. Dampers and damper operators.
      b. Diffusers, grills, and registers.
   3. Specific requirements for refrigerant piping.

1.02 REFERENCES

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
   1. 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
   2. 270 - Sound Rating of Outdoor Unitary Equipment.
   3. 340/360 - Performance Rating of Commercial and Industrial Unitary Air Conditioning and Heat Pump Equipment.
   4. 430 - Performance Rating of Central Station Air-handling Unit Supply Fans.

B. Air Movement and Control Association International, Inc. (AMCA):
   1. 11 - Certified Ratings Program Operating Manual.
   2. 210 - Laboratory Methods for Testing Fans for Certified Aerodynamic Performance Rating.
   3. 211 - Certified Ratings Program — Product Rating Manual for Fan Air Performance.
   4. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
   5. 311 - Certified Ratings Program — Product Rating Manual for Fan Sound Performance.
   6. 500 - Laboratory Methods of Testing Dampers for Rating.
   7. 511 - Certified Ratings Program Product Rating Manual for Air Control Devices.

C. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

D. American National Standards Institute (ANSI):
   1. Z21.47 - Gas Fired Central Furnaces (except Direct Vent Central Furnaces).

E. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):
   1. Standard 15 - Safety Standard for Refrigeration System.
   2. Standard 52.2 - Methods of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

F. American Society of Mechanical Engineers (ASME):
   1. RTP-1 - Reinforced Thermoset Plastic Corrosion-Resistant Equipment.

G. ASTM International (ASTM):
   1. B32 - Standard Specification for Solder Metal.
   2. B75 - Standard Specification for Seamless Copper Tube.
   3. B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   4. B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
   5. B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fitting.
   6. C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   7. D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   8. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   9. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   10. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   11. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   12. D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

H. National Bureau of Standards: NBS PS15-69 - Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment.

I. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

J. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
   2. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

K. National Roofing Contractors Association (NRCA).

L. International Association of Plumbing and Mechanical Officials (IAPMO):
   1. IS 3 - Installation Standard for Copper Plumbing Tube, Pipe, and Fittings.

M. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

N. Underwriters Laboratories, Inc. (UL):
    1. 555 - Standard for Fire Dampers.
    2. 555C - Standard for Safety Ceiling Dampers.
    3. 555S - Standard for Smoke Dampers.
    4. 900 - Standard for Air Filter Units.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination.
    1. Provide roof mounted HVAC equipment information required in the preparation of roofing drawings, including, but not limited to:
        a. Location.
        b. Size.
        c. Weight.
        d. Anchoring and support details.

1.04 SUBMITTALS

A. Where items in this Section are components of equipment or systems specified in other sections, include data for this Section's components with the equipment or system Submittal.

B. When products are specified in this Section but are not referenced in other Technical Sections, submit:
    1. As specified in Section 01_33_00 - Submittal Procedures.
    2. Product data:
        a. Sufficient to substantiate specified requirements.
    3. Description of coating system and instructions for field touch up and re-coating.

PART 2 PRODUCTS

2.01 GENERAL

A. Technical Sections product requirements supersede conflicting requirements in this Section.

B. As specified in Section 01_60_00 - Product Requirements.

C. Electrical:
    1. Components and assemblies.
    2. Carry UL listing marking.
    3. In accordance with NEC requirements.

D. Fans:
    1. Rated and labeled in accordance with AMCA 210 and AMCA 211.
    2. Belt drive systems:
        a. Adjustable for minimum within 5 percent speed change.
        b. Rated for 150 percent of maximum motor horsepower.

E. Unitary air conditioners and heat pumps:
   1. Rated in accordance with AHRI 210/240 or 340/360, AHRI 270, and AHRI 430.
   2. In accordance with ASHRAE Standard 15.
   3. Heating: Certified in accordance with ANSI Z21-47.
   4. Refrigerant:
      a. Fully charged with R-454B.
      b. Compliant with ASHRAE 15.
      c. HFO refrigerant with global warming potential (GWP) of 700 or less.
      d. Must have a refrigerant monitoring system and be rated in accordance with UL 60335-2-40.

F. Filters:
   1. Media: UL 900 listed.

G. Insulation and adhesives: In accordance with NFPA 90A requirements for flame spread and smoke generation.

H. Roof curbs: Supplied by the manufacturer of the product requiring the curb.

I. Factory coating: For equipment with factory coatings, manufacturer to supply 2 containers (each about a pint) of the paint for Contractor/Owner touch up.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. General:
   1. Environmental conditions as specified in Section 01_81_50 - Design Criteria.
   2. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 23_09_13 - Instrumentation and Control Devices for HVAC.

B. Fans:
   1. Sharply rising pressure characteristics throughout the operating range and beyond the efficiency peak.
   2. Peak operating points to be as close as possible to the maximum efficiency and whose operating range is within the normal fan selection range.
   3. Bearings rated in accordance with ABMA 9 or 11 for a L10 life rating of not less than 50,000 hours.
   4. Total sound power levels in the 8 octave band range in accordance with AMCA 301, not to exceed the lesser of the following or the sones level indicated on the Drawings.

Sound Power Level, decibels levels referenced to 10 to 12 watts								
Frequency, Hz	63	125	250	500	1,000	2,000	4,000	8,000
General	100	98	94	88	84	84	78	75

   5. Shall comply with AMCA 11 and bear the AMCA Certified Ratings Program seal for air performance and sound performance according to AMCA 211 and AMCA 311.

C. Unitary air conditioners and heat pumps:
   1. Outdoor noise levels in the 8 octave band ranges, as measured in accordance with AHRI 270 shall not exceed the following:

Octave Bands								
Unit Nominal Capacity (Tons)	**63**	**125**	**250**	**500**	**1,000**	**2,000**	**4,000**	**8,000**
0 to 5	64	70	71	74	74	71	67	67
6	79	85	78	74	71	73	66	59
7-1/2 to 10	64	70	73	79	82	78	74	67
12 and larger	84	88	84	83	84	78	72	68

   2. Capable of starting and cooling from 45 to 125 degrees Fahrenheit ambient outdoor air temperature and exceeding the maximum load criteria of AHRI 210/240 or 340/360.
   3. Heat pumps capable of starting and heating at or above 0 degrees Fahrenheit outdoor ambient air temperature.
   4. Minimum cooling, Energy Efficiency Ratio (EER) and Integrated Energy Efficiency Ratio (IEER), as rated in accordance with AHRI 210/240 or 340/360 for split systems and packaged units is as follows:

Equipment Type	Net Cooling Cap (Btu per hour)	SEER2	IEER
Air Cooled	<65,000	14.3	N/A

   5. Units with heating capabilities: Meet or exceed the following:
      a. Annual fuel utilization efficiency: 80 percent.
      b. Steady state efficiency: 80 percent.

D. Filters:
   1. Efficiency: 45 to 50 percent dust spot efficiency when rated in accordance with ASHRAE Test Standard 52.2.

E. Smoke detector requirements:
   1. Provide supply and exhaust fans greater than or equal to 2,000 cubic fpm with smoke detectors:
      a. Duct or fan mounted smoke detector as specified in Section 23_09_13 - Instrumentation and Control Devices for HVAC.

2.03 DAMPERS

A. General:
   1. Type, style, and size as indicated on the Drawings.
   2. Components: Include with each damper:
      a. Type, frame, actuators, clips, connectors, and other accessories necessary for mounting.
         1) Manual actuators: Factory supplied locking quadrant on factory mounted stand-off bracket.
            a) Bracket finish to match frame.
         2) Electric actuators when indicated on the Drawings.

3. Leakage class, when specified, to be in accordance with AMCA 511 and product to bear AMCA Rating Seal for Air Leakage.
    a. Blade seals to be mechanically attached.
4. Fire dampers and combination smoke/fire dampers to have duct access door near damper as specified in the Technical Sections.

B. Volume control and balancing type dampers (BD):
1. BD-7, Style 7; round, heavy duty, volume control damper:
    a. Manufacturers: One of the following or equal:
        1) Greenheck.
        2) Ruskin, Model 912.
    b. Class 1A leakage.
    c. Frame: Molded vinyl ester resin fiberglass channel.
        1) In accordance with ASME RTP-1.
            a) 30-mil resin rich interior corrosion layer.
        2) Flanges integral to the web layup.
    d. Blade: Vinyl ester resin fiberglass, horizontal, butterfly:
        1) In accordance with ASME RTP-1.
            a) 30-mil resin rich interior corrosion layer.
        2) Angle stops.
    e. Blade axle: Pultruded vinyl ester resin fiberglass rod:
        1) PTFE bearings and axle shaft seal.
        2) Hand quadrant: Type 316 stainless steel.
    f. Blade seal:
        1) Viton™.
2. BD-8, Style 8; rectangular, heavy-duty, volume control damper:
    a. Manufacturers: One of the following or equal:
        1) Greenheck.
        2) Ruskin, Model 1108AF.
    b. Class 1 leakage.
    c. Frame: Pultruded vinyl ester resin fiberglass channel.
        1) In accordance with ASME RTP-1.
            a) 30-mil resin rich interior corrosion layer.
        2) Flanges integral to the web layup.
        3) Type 316 stainless steel linkage out of airstream.
    d. Blade: Airfoil shape opposed blade.
        1) 30-mil resin rich corrosion layer.
    e. Blade axle: Pultruded vinyl ester resin fiberglass rod.
        1) 30-mil resin rich corrosion layer.
        2) Molded PTFE bearings.
    f. Seals:
        1) Blade: Viton™.
        2) Jamb: Type 316 stainless steel.
3. BD-9, Style 9; rectangular, linear volume control damper:
    a. Manufacturers: One of the following or equal:
        1) Greenheck, Model HCD-240.
        2) Ruskin, Model CD403.
    b. Class 1 leakage.
    c. Frame: Aluminum hat channel.
        1) 6063-T5 extruded, anodized.

2) Mounting flanges on both sides.
3) Containing concealed linkage.

d. Blades: Aluminum, airfoil shape, parallel and opposed action.
1) 6063-T5 extruded, anodized.
2) Horizontal orientation.
3) 57 percent opposed blades.

e. Blade axle: 1/2-inch hexagonal steel.
1) Electroless nickel plated.
2) Molded PTFE bearings.

f. Seals:
1) Blade: EDPM.
2) Jamb: Flexible metal compression.

g. Finish: Mill.

4. BD-10, Style 10; round, light duty, volume control damper:
a. Manufacturers: One of the following or equal:
1) Greenheck.
2) Ruskin, Model CDRS82.

b. Frame: Aluminum sheet.
1) 6063-T5.

c. Blade: Aluminum sheet:
1) 6063-T5.
2) Single, stiffened as required.
3) Horizontal butterfly.

d. Blade axle: Steel rod:
1) Electroless nickel plated.
2) Type 304 stainless.

e. Finish: Mill.

5. BD-13, Style 13; fiberglass, inlet volume control damper:
a. Manufacturers: One of the following or equal:
1) Daniel Mechanical.
2) Ruskin, Model 851FG.

b. Frame: Vinyl ester resin fiberglass channel.
1) 100-mil corrosion barrier on internal surfaces.
2) Flanged ends with bolt holes drilled to match fans inlet.

c. Blades:
1) Vinyl ester resin fiberglass:
a) 100-mil corrosion barrier.
2) Flat capped hub:
a) Material to match blades.

d. Bearings: Molded graphite impregnated PTFE, flanged sleeve.
e. Drive shaft: Type 316 stainless steel full length rod.
f. Axles: Pultruded FRP rod.
g. Shaft seals: Double O-ring.
h. Linkage: Type 316 stainless steel, including swivels and bearings.
i. Hub: Type 316 stainless steel or FRP flat panel.
j. Hardware: Type 316 stainless steel.
k. Operator:
1) 12 inch and smaller: Lever arm with locking manual quadrant Type 316 stainless steel construction or epoxy coated worm gear.
2) Larger than 12 inch: Epoxy coated worm gear.

l. Connections: Type 316 stainless steel nuts, bolts, and washers.
m. Field paint if scheduled and as specified in Section 09_96_01 - High-Performance Coatings for surface preparation requirements.

6. BD-14, Style 14; round fiberglass damper:
   a. Manufacturers: One of the following or equal:
      1) Daniel Mechanical.
      2) Engineered Composite Systems.
   b. Zero-leakage air isolation damper.
   c. Materials of construction:
      1) Body: Vinyl ester FRP.
      2) Blade: Vinyl ester FRP.
      3) Blade seal: PTFE encapsulated O-ring, EPDM O-ring.
      4) Blade stop: FRP integral to the damper body.
      5) Shaft: Type 316 stainless steel or vinyl ester FRP.
      6) Shaft seal: Viton™ O-ring.
      7) Bearings and bushings: Graphite impregnated PTFE.
      8) Hardware: Type 316 stainless steel.
      9) Maximum operating temperature: 175 degrees Fahrenheit.
      10) Minimum pressure: 30-inches water column.
      11) Resin system: Fire retardant vinyl ester with MEKP cure system.
      12) Internal corrosion barrier: Minimum 100-mil thickness.
      13) Connections: Flanged in accordance with NBS PS15-69 Table 2.
      14) External coating: Gel coat with ultraviolet inhibitors.
      15) Gaskets: EPDM.
   d. Maximum leakage: 4.4 cfm per square feet at 30-inches water column.
   e. Actuators:
      1) Dampers 24 inches and smaller:
         a) Hand quadrant actuator fabricated from Type 316 stainless steel with a fully adjustable slot with extra hole drilled in handle to permit locking pin once system has been balanced.
         b) Provide drilled hole in the actuator handle support plate to permit locking in the full open and full closed positions.
      2) Dampers larger than 24 inches: Epoxy coated gear operator with locking handwheel.
      3) Dampers below grade or located in areas not normally accessible (all sizes) such as in wetwells or junction boxes:
         a) Operator: Geared 1/4 turn, Dynatorque stainless steel series DT7 (no chain wheel) or DT21 (with chain wheel) or equal.
         b) Material:
            (1) Shaft: Type 316 stainless steel shaft, enclosure, and hardware.
            (2) Gears: Type 316 stainless steel or 6061 aluminum.
         c) Extension:
            (1) Type 316 stainless steel with 2-inch operating nut, minimum 1-inch diameter or equal to the shaft diameter, whichever is larger.
            (2) Provide an indicator at the top of the extension stem to indicate full open and full closed positions.

4) Dampers located 6 feet or more above finished floor or grade elevation shall use geared operators as specified above with chain wheel operator and chain extending to within 3 feet of finished floor or grade elevation.
   a) Manufacturers: One of the following or equal:
      (1) Babbitt.
      (2) Rotohammer.
   b) Aluminum chain wheels equipped with Type 316 stainless steel chain.
   c) For installations where operator and chain weight exceed 40 pounds the damper shall be reinforced to accommodate the added weight.

C. Backdraft dampers (BDD):
   1. BDD-1, Style 1; counterbalanced backdraft damper:
      a. Manufacturers: One of the following or equal:
         1) Greenheck.
         2) Ruskin, Model CBD6.
      b. Frame:
         1) Minimum depth: 2.25 inches.
         2) Minimum thickness: 0.125 inches.
         3) Material: 6063T5 aluminum.
         4) With insect screen and water stop.
      c. Blades:
         1) Minimum thickness: 0.070 inches.
         2) Material: 6063T5 aluminum.
         3) High strength nylon bearings.
         4) Elastomer edge seals.
         5) Aluminum tie-bar.
         6) Blades require no more than 4.25 inches clearance beyond frame when fully open.
      d. Counterbalance:
         1) Zinc plated bar on blades.
         2) Adjustable down to 0.01-inch wg opening.
      e. Finish:
         1) Mill.
   2. BDD-2, Style 2; fiberglass, counterbalanced backdraft damper:
      a. Manufacturers: One of the following or equal:
         1) Daniel Mechanical.
         2) Ruskin, Model 426.
      b. Frame:
         1) Minimum depth: 8 inches.
         2) Material: Vinyl ester resin fiberglass.
         3) Flange mount.
      c. Blades:
         1) Minimum thickness: 0.125 inches.
         2) Series 625 vinyl ester resin on 0.75-inch diameter fiberglass axles with PTFE bearings.
         3) Blades require no more than 2 inches of clearance beyond frame when fully open.

d. Counterbalance:
    1) Type 316 stainless steel counterbalance weight and arm.
    2) Adjustable down to 0.02-inch wg opening.
e. Finish:
    1) 2 coats of PVDF with color selected by the Owner from the manufacturer's standard.

2.04 DAMPER OPERATORS

A. General: Provide manual or electric damper operator for each damper furnished as indicated on the Drawings.

B. Manual operators by damper manufacturer:
1. Operate damper manually with a force not exceeding 20 pounds.
2. Provide with locking quadrant.
3. Provide 3/8 inch, or larger, square double-ended drive shaft adequate for required damper torque, with machined keyways allowing for mounting in 2 positions, 90 degrees apart.
4. Provide sufficient number of operators for torque required to operate damper.

2.05 DIFFUSERS, GRILLES, AND REGISTERS

A. Provide diffusers, grilles, and registers manufactured by the same manufacturer.

B. Provide style and size as indicated on the Drawings.

C. Components: Include specified style with frame, clips, connectors, and other accessories necessary for mounting.

D. Supply diffuser, grille, and register styles:
1. SR-3, Supply Register Style 3:
    a. Manufacturers: One of the following or equal:
        1) Titus Manufacturing Corp, 272FL.
        2) Krueger.
    b. Type: Aero-blade series (3/4-inch) with aluminum border.
    c. Installation: When duct mounted is indicated on the Drawings, provide 4-inch drop frame.
    d. Faceplate:
        1) Removable grille with double deflection blades spaced at 3/4 inch.
        2) Front blades parallel to long dimension.
        3) Gasket at frame.
    e. Core:
        1) Adjustable vanes.
        2) Rectangular or round neck to match ducting.
    f. Damper:
        1) Opposed blade volume control damper suitable for use with ducting type.
        2) Adjustable through the face of the unit.
    g. Materials: Aluminum frame, core, damper, and faceplate.

2. RR-3/ER-3, Return/Exhaust Register Style 3:
    a. Manufacturers: One of the following or equal:
        1) Titus Manufacturing Corp, 350FL.
        2) Krueger.
        3) Metal Industries, Inc., (MetalAire).
    b. Size: Rectangular grille with size as indicated on the Drawings.
    c. Installation: When duct mounted is indicated on the Drawings, provide 4-inch drop frame.
    d. Faceplate: Removable grille with fixed blades spaced at 3/4 inch; front blades parallel to long dimension with 35-degree deflection; provide gasket at frame for sealing.
    e. Core: When connected to ducting, provide suitable rectangular or round neck to match ducting.
    f. Damper: When connected to ducting, provide opposed blade volume control damper suitable for use with ducting type.
        1) Adjustable through the face of the unit.
    g. Materials: Aluminum frame, core, damper, and faceplate.

2.06 SCREENS

A. Required on all fans and louvers unless otherwise indicated on the Drawings.

B. Characteristics and features:
    1. Bird screen: 1/2-inch mesh by 14 gauge.
        a. For exhaust applications.
    2. Insect screens: 18 by 14 mesh.
        a. For intake applications.
    3. Screens and frames, same material as ductwork, hood, louver, fan, or equipment connected to screen.
    4. Screens secured in frames.

2.07 FLEXIBLE CONNECTORS

A. Provide flexible duct connectors at connections to fans and other air movement equipment as indicated on the Drawings.

B. FL-1, Duct to Duct Flexible Connection:
    1. Fabric shall be fire resistant, waterproof, mildew-resistant, and airtight.
        a. At least 4 inches of fabric shall be exposed.
        b. Flexible connections shall be in accordance with the requirements of UL and NFPA.
    2. Interior locations:
        a. Manufacturers: One of the following or equal:
            1) Flextech Engineering.
            2) Ventfabrics, Ventglas.
        b. Fabric for flexible connections installed inside office areas shall be Neoprene coated glass fabric suitable for a temperature range of 20 to 180 degrees Fahrenheit and shall have a weight of at least 27 ounces per square yard and a thickness of 0.024 inches.

3. Exterior locations:
    a. Manufacturers: One of the following or equal:
        1) Flextech Engineering.
        2) Ventfabrics, Ventlon.
    b. Fabric for flexible connections exposed to sunlight or the weather shall be glass fabric coated with CSPE suitable for a temperature range of -10 to 250 degrees Fahrenheit and shall have a weight of at least 24 ounces per square yard and a thickness of 0.019 inch.

C. FL-2, Duct to Duct Flexible Connection, Corrosive Environment:
1. Manufacturers: The following or equal:
    a. Ventfabrics, Ventel.
2. Fabric for flexible connections exposed to chemicals shall be glass fabric coated with Teflon™ and suitable for a temperature range of -10 to 500 degrees Fahrenheit and shall have a weight of at least 14 ounces per square yard and a thickness of 0.014 inch.

2.08 REFRIGERANT PIPING

A. Seamless copper tube:
1. Type:
    a. Straight lengths: ASTM B75, USN Alloy C12200, H55 Temper.
    b. Coiled lengths: ASTM B280, USN Alloy C12200, O60.
    c. Outside diameter sized, minimum wall thickness in accordance with ASTM B280 and ASTM B75.
2. Non-VRF system:
    a. Solder: ASTM B32, Alloy Grade Sb5.
    b. Flux: ASTM B813.

2.09 CONDENSATE DRAIN PIPING

A. PVC:
1. PVC pipe: Designation PVC 1120 in accordance with ASTM D1785 and appendices:
    a. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454 B material in accordance with ASTM D1784.
    b. PVC pipe: Schedule 40 unless otherwise indicated on the Drawings.
2. Fittings:
    a. Supplied by the pipe manufacturer.
    b. Pressure fittings: In accordance with ASTM D2466 or ASTM D2467.
    c. DWV fittings: In accordance with ASTM D2665.
3. Solvent cement: In accordance with ASTM D2564:
    a. Manufacturers: The following or equal:
        1) Primer: IPS Corp Type P-70™.
        2) Cement: IPS Corp Type 724™ cement or cement certified by the manufacturer for chemical service.

2.10 PIPE INSULATION

A. General:
   1. As specified in Section 01_60_00 - Product Requirements.
   2. Insulation thicknesses: In inches as specified in the following table.
      a. Thickness shown is nominal.
      b. Manufacturing tolerance of 15 percent variation is permissible.

Table 1. Required Insulation Thicknesses (Inches)		
Service Temperature Range(1)	**Nominal Pipe Diameters**	
	1 Inch and Less	**1.25 to 2 Inches**
100 to 200 degrees Fahrenheit	1.5	1.5
40 to 100 degrees Fahrenheit	0.5	1.0
Notes: (1) As specified in Table 2. Insulation Schedule, at the end of this Section.		

B. Insulation, Type 1:
   1. Manufacturers: One of the following or equal:
      a. Aeroflex USA Inc., Aerocel® AC.
      b. Armacell®, AP Armaflex.
   2. Insulation material: Closed cell elastomeric insulation.
   3. Minimum temperature range: -40 degrees Fahrenheit to 220 degrees Fahrenheit.
   4. K-factor at 75 degrees Fahrenheit: Not more than 0.27 Btu-inch/hour-square feet-degrees Fahrenheit.
   5. Fire ratings:
      a. Flame spread: 25 or less.
      b. Smoke density: 50 or less for insulation thicknesses up to 1.5 inches.
   6. Joints: Seal with the manufacturer's recommended contact adhesive to form a continuous water barrier.

C. Insulation jackets:
   1. Type 1:
      a. Manufacturers: One of the following or equal:
         1) Johns Manville, Zeston® 2000 PVC.
         2) Proto Corp., LoSMOKE PVC.
         3) Speedline® Corp., Smoke-Safe™ PVC.
      b. Material: Ultraviolet-resistant polyvinyl chloride jacketing, 20-mil minimum thickness.
      c. Fire rating: 25 maximum flame spread, smoke developed 50 or less.
      d. Color: White.
      e. Overlap: 1 inch minimum at joints and fittings.
      f. Joint seal: PVC solvent welded or adhesive as recommended by the manufacturer.
      g. Fittings: Factory made with full thickness insulation.

D. Vapor barriers:
   1. Type 1:
      a. Material: White Kraft paper bound to aluminum foil in accordance with ASTM C1136, Type 1.
      b. Permeability: 0.02 perms or lower.
      c. Maximum flame spread rating: 25.
      d. Edge seal: Pressure-sensitive tape lap seal.
      e. Circumferential joints: 4-inch wide tape or 4-inch overlap with adhesive seal.
   2. Type 2:
      a. Manufacturers: One of the following or equal:
         1) Benjamin Foster, No. 30-76.
         2) Childers Products, CP10/11 Vi-Acryl.
         3) Foster Products, 36-10/46-10 Weatherite.
         4) Insul-Coustic, No. I.C.-580.
      b. Material: Mastic.

E. Insulation schedule:

Table 2. Insulation Schedule

Service Designation(1)	Location(2)	Insulation Type	Jacket Type	Service Temp. °F(3)	Vapor Barrier
HVAC Refrigerant	Interior or Exterior	1	1	40 to 200	Required
HVAC Condensate	Interior or Exterior	1	1	Below 60	Required

Notes:
(1) Refer to the Pipe Schedule in Section 40_05_00.01 - Common Work Results for General Piping for service designations.
(2) Insulation jackets are not required for interior installations that are concealed. See definitions for description of concealed locations.
(3) Unless noted otherwise, use service temperature range provided in this table to establish insulation thickness as required by Table 1.

2.11 EQUIPMENT NAMEPLATES

A. Provide a nameplate with the following markings, plainly visible after installation:
   1. Manufacturer’s name, trademark, or other descriptive marking to identify specific equipment.
   2. Where equipment is electrically powered:
      a. Supply voltage, phase, frequency, and full-load current.
      b. Power source or circuit ID.
      c. Short-circuit current rating based on one of the following:
         1) Rating of a listed and labeled assembly.
         2) Rating established utilizing an approved method.

2.12 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01_60_00 - Product Requirements.

B. Inspect fasteners for proper tightness.

C. Ship units in one piece (or modular, if required), factory assembled, piped, internally wired, and factory tested.

D. Provide:
   1. Filters: 2 extra (3 total) sets per each unit with filters.
   2. Sheaves and belts: 1 set for change-out for final balance per unit installed.
   3. Belts: 1 extra set for each unit installed as determined by final balance.

E. Provide a 2-year supply of maintenance products as specified in the manufacturer's maintenance literature.

PART 3 EXECUTION

3.01 GENERAL

A. Technical Sections execution requirements supersede conflicting requirements in this Section.

B. As specified in Section 01_60_00 - Product Requirements.

C. Inspect fasteners for proper tightness.

D. Provide temporary closures for openings designed for airflow.

3.02 INSTALLATION

A. Examine and verify details and sections as indicated on the Drawings, ascertain adequacy, and determine conflicts in dimensions and clearances.
   1. Take measurements and verify dimensions to ascertain fit of installation.
   2. Ascertain structural sufficiency to support installation.
   3. Ascertain that supports and openings are correctly located; otherwise cut new openings where required.
   4. Confirm specified thermostat or other controls are compatible with specified equipment.

B. Install in accordance with the manufacturer's instructions.
   1. Electrical products installation in accordance with NFPA 70 NEC.
   2. If there are conflicts, NEC supersedes the manufacturer's instruction.
      a. Notify the Engineer of conflicts.

C. Equipment and ducts:
   1. Remove dust and debris before installation.
   2. Protect from dust and debris by covering openings with tape or plastic during installation and until equipment is operated.
   3. Adjust alignment of ducts to resolve conflicts with the work of other trades.
   4. Install and wire unitary air conditioners, controls, and thermostats in accordance with the manufacturer's recommendations.

5. Provide flexible duct and flexible piping connections at connections to unitary air conditioners.
    a. FL-1 and FL-2, Flexible Connections:
        1) Install at building expansion joints and as indicated on the Drawings.
        2) Install with collar and metal band to form airtight joints.
        3) Install with minimum 4 inches of slack in fabric.
        4) Install with minimum 3 inches of specified material on each side of fabric.
        5) Exterior locations: Install sheet metal weather cover over fabric.
        6) Duct alignment shall be a maximum of 1/2-inch offset.
        7) Minimum/maximum gap shall be 2 inches and 6 inches.
        8) Lap longitudinal joints and glue in accordance with the manufacturer's recommendations.
6. Lubrication lines and fittings:
    a. Support and protect lines from source to point of use.
    b. Fittings:
        1) Bring to outside of equipment in manner such that fittings are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
        2) Mount together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
7. Concrete surfaces designated to receive non-shrink grout under equipment:
    a. Heavy sandblast concrete surface in contact with non-shrink grout.
    b. Clean concrete surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bond to non-shrink grout.
    c. Saturate concrete with water. Concrete shall be saturated surface damp at time non-shrink grout is placed.
8. Remove dust and debris from ductwork and equipment at completion of installation.
9. Set grilles, dampers, and diffusers to achieve flows and flow patterns indicated on the Drawings.

D. Refrigerant piping:
1. Support copper tubing as specified in Section 40_05_07.01 - Pipe Supports and Section 40_05_07.03 - Preformed Channel Pipe Support System.
2. Clean copper lines with high-pressure air after first disconnecting piping at instruments, filters, pressure reducers, valve operators, and other special devices.
3. Installation of copper tubing:
    a. In accordance with ASTM B828 and IAPMO IS 3.
    b. In straight runs, supported at intervals close enough to avoid sagging.
    c. Make cuts square with a tubing cutter or with a 32-tooth hacksaw.
        1) Provide a sizing tool to correct distortions.
4. Ream the inside of the tubing and remove burrs from the outside, holding the end of the tubing downward and preventing chips and fillings from entering the tubing.

5. Perform flaring with a flare block and yoke type screw feed flaring tool:
    a. After removing the tubing from the flare block, inspect both surfaces of the flare for splits, cracks, or other imperfections.
    b. Where there are imperfections, cut off the imperfect flare and prepare a new flare.

E. Gas, water piping, drains, and venting in accordance with the authority having jurisdiction and applicable codes.

F. Roof curbs: Install in accordance with the NRCA manual.

G. Completed equipment installations must have confirmation that:
1. Equipment is properly assembled.
2. Equipment moves or rotates in the proper direction.
3. Shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
4. No unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
5. Installation meets the requirements for intended use as well as the specified vibration and noise tolerances.

END OF SECTION

SECTION 23_05_93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Testing air systems installed as part of this Contract.
   2. Testing existing air systems affected by the installation of new equipment.

1.02 REFERENCES

A. Associated Air Balance Council (AABC):
   1. National Standards Total System Balance.

B. National Environmental Balancing Bureau (NEBB):
   1. Procedural Standards for Testing, Adjusting, and Balancing Environmental Systems.

C. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   1. HVAC Systems - Testing, Adjusting, and Balancing.

D. Testing, Adjusting, and Balancing Bureau (TABB):
   1. TAB Procedural Guide.

1.03 SUBMITTALS

A. Resumes of proposed supervisor and personnel showing training and qualifications.
   1. Include courses, exams, or tests relating to HVAC testing - taken and passed.

B. Testing plan:
   1. At least 30 days prior to starting field work.
   2. Set of report forms completed with design flow values and installed equipment pressure drops, and required cubic feet per minute for air terminals.
   3. Heating, ventilating, and air conditioning system schematic similar to Figure 6-1 in SMACNA HVAC Testing, Adjusting, & Balancing.
   4. Complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each showing:
      a. Manufacturer and model number.
      b. Description and use when needed to further identify instrument.
      c. Size or capacity range.
      d. Latest calibration date.
   5. Proposed schedule for testing and balancing.

C. Report:
   1. Not more than 45 days prior to the Contractor's request for final inspection, submit the draft report on applicable reporting forms.

2. At least 15 days prior to the Contractor's request for final inspection, submit 3 copies of final reports incorporating the Engineer's comments on the draft report.
3. List of instruments used and last date of calibration of each.
4. Procedures followed for testing, adjusting, and balancing.
5. Identification and succinct description of systems included in report.
6. Initial balance test results made with dampers and air control devices in full open positions.
7. Description of final locations and sizes, including opening area and dimensioned configuration of orifices and other restrictions used to achieve final balanced flows.
8. Description of final location and opening positions of dampers, registers, louvers, and valves.
9. Schematics of systems included in report; use schematics as part of testing, adjusting, and balancing report to summarize design and final balanced flows.
10. Testing, adjusting, and balancing report forms.
11. Final field results established for system balancing, including airflow, fan speeds, and fan static pressures at the fan inlet and outlet.
12. Appendices.
    a. Raw field data taken during testing.
    b. Sample calculation sheet for each type of calculation made to convert raw field data to final results.
    c. Initial air balance results with dampers and registers in full open position; include airflow at all inlets and outlet, initial fan speed, and fan suction and discharge pressures.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Work of testing, adjusting, and balancing of heating, ventilation, and air conditioning systems to be by an independent testing agency and a certified member in good standing with AABC, NEBB, or TABB.

B. Field testing to be performed or directly supervised by personal who have passed a test and balance course or exam and is an AABC, NEBB, or TABB certified supervisor.

3.02 PREPARATION

A. Prior to start of testing, adjusting, and balancing, verify that:
   1. System installation is complete in accordance with the requirements for completed equipment installations specified in Section 23_05_00 - Common Work Results for HVAC and capable of full operation.
   2. Outside conditions are within reasonable range relative to design conditions.
   3. Lighting fixtures are energized.

4. Special equipment such as computers, laboratory equipment, and electronic equipment are in full operation.
5. Requirements for preparation for testing and balancing have been met for elements of each system which require testing.

3.03 FIELD QUALITY CONTROL

A. Test, adjust, and balance each separate complete heating, ventilating, and air conditioning systems.
   1. Include existing heating, ventilating, and air conditioning components when affected by the Work.

B. Perform testing, adjusting, and balancing cycles until airflows meet acceptance criteria.
   1. Ascertain airflow balance between overall requirements and flow in individual supply and exhaust grilles.

C. Initial testing, adjusting, and balancing:
   1. Test each system with dampers, grilles, orifices, and other variable airflow devices in their full open position; measure and report initial airflows, fan speed, and fan static pressures at fan inlet and outlet.
   2. Adjust total system flow downward or upward by adjusting fan speed until one inlet or outlet is at indicated flow and all other flows exceed indicated flows.
   3. Adjust fan speed by changing fan drives or sheaves as necessary.

D. Subsequent testing, adjusting, and balancing:
   1. Perform adjustments by adjusting dampers, louvers, or size of orifices or plates.
   2. Measure and record air volume discharged at each inlet and outlet and adjust air inlets and outlets to design air volumes within 0 to 5 percent over design rates.
   3. Adjust fan speeds and motor drives within drive limitations, for required air volume.
   4. Measure air flow and static pressures and adjust air supply and exhaust fan units to deliver at least 100 to 105 percent of the design air volume.
   5. Measure and record static air pressure conditions on fans, including filter and coil pressure drops and total pressure across the fan.
   6. Evaluate building and room pressure conditions to determine adequate supply and return air conditions.
   7. Evaluate space and zone temperature of conditions to determine adequate performance of the systems to maintain temperatures without draft.
   8. Permanently mark final balance positions of balancing dampers.

E. Develop heating, ventilating, and air conditioning system schematics similar to Figure 6-1 in SMACNA Testing, Adjusting, and Balancing.

F. Accurately record the required data on AABC, NEBB, or TABB test and balance report forms.

G. Measure amperage draw of fan and pump motors at final balance.

H. Test primary source equipment in accordance with AABC, NEBB, or TABB procedures.
   1. Primary source equipment includes items listed in this Section not previously tested as part of this testing, adjusting, and balancing work.
   2. Complete appropriate AABC, NEBB, or TABB equipment test forms for each piece of equipment.
   3. Calculate cooling and heating capacities to show conformance with specified capacities.
   4. Adjust equipment as needed to deliver specified cooling and heating loads.
   5. Record final equipment performing characteristics and adjustment settings in the final design report.

I. Testing, adjusting, and balancing acceptance criteria:
   1. Procedures successful and complete when heating, ventilating, and air conditioning systems and components are functioning properly and system air flows are within specified tolerances of design flows.

END OF SECTION

SECTION 23_09_13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Controls for heating, ventilating, and air conditioning (HVAC) systems.

1.02 REFERENCES

A. CSA International (CSA).

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).

C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
   2. 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

D. Restriction of Certain Hazardous Substances (RoHS).

E. Underwriters Laboratories, Inc. (UL):
   1. 13 - Standard for Safety Power-Limited Circuit Cables.
   2. 268A - Standard for Smoke Detectors for Duct Application.
   3. 508 - Standard for Industrial Control Equipment.
   4. 1479 - Fire Tests of Through-Penetration Firestops.
   5. 1685 - Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 23_05_00 - Common Work Results for HVAC.

C. Shop Drawings:
   1. Manufacturer’s information, including:
      a. Catalog information clearly marked to show specific products, models, and sizes being furnished.
      b. Component cut sheets.
   2. Control diagrams showing the interconnection of control components, including wiring terminal strip diagrams.
   3. Detail drawings showing control panel layout and dimensions, including control panel terminal strips for wiring to outside control devices and panels.

D. Provide vendor operation and maintenance manual as specified in Section 01_78_24 - Operation and Maintenance Manuals.

1.04 QUALITY ASSURANCE

A. Control system shall be designed in accordance with UL and CSA standards.

1.05 DELIVERY, STORAGE, AND HANDLING

A. System control products shall be stored and handled in accordance with the manufacturer's recommendations.

1.06 SITE CONDITIONS

A. Elevation and ambient conditions as specified in Section 01_81_50 - Design Criteria.

1.07 WARRANTY

A. Special warranties: Warranty period begins at date of Project acceptance or first date of beneficial use by the Owner.
   1. 1 year parts and on-site labor for components, systems, and programming.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. General requirements:
   1. Electrical components shall be UL-listed and meet the design and installation requirements of the NEC.
   2. Provide necessary electrical power and control systems, components, and wiring to make a complete functioning system.
   3. Comply with electrical sections for electrical power and control systems.
   4. System control functions to perform as described in Products.
   5. Materials: New, free from defects, and of the quality specified.
   6. Common manufacturer: Provide components, component accessories, and devices, as much as possible, by the same manufacturer throughout the Work.
   7. Mount control components and devices in accessible locations for maintenance and as recommended by the manufacturer. Provide necessary manufacturer-approved mounting and configuration hardware for mounting and operation of control components and devices.

2.02 CURRENT SWITCHES

A. Veris Industries, H series or equal.

B. Rated for current range of the equipment.

C. Used to determine low current inferring loss of air flow.

2.03 RESISTANCE TEMPERATURE DETECTOR (RTD) TYPE TEMPERATURE TRANSMITTER

A. Manufacturers: One of the following or equal:
   1. Greyston Energy Systems Inc., Model TDHRBF12XA002.
   2. Omega Engineering, Model EWSA-PT100-TX.

B. Characteristics and features:
   1. Sensor: Platinum RTD 100 ohm or 1,000 ohm.
   2. Power supply: 10 to 30 VDC, loop powered.
   3. Probe sensing range: 32 to 158 degrees Fahrenheit.
   4. Output signal: 4-20 mA.
   5. Transmitter accuracy: Within 0.1 percent of span.
   6. Enclosure:
      a. NEMA 4X (IP65) for non-hazardous areas.
      b. NEMA 7 for hazardous areas.
   7. Wiring connection: Screw terminal block, 2-wire.

2.04 HVAC CONTROL DESCRIPTIONS

A. Provide control systems that will maintain room or area comfort under changing ambient conditions and varying use. Descriptions in this Section are general in nature and do not cover every mode of operation.

B. Sludge Pump Room Control Sequences:
   1. Exhaust fan EF-42032 will operate continuously to maintain 6 ACH.
      a. EF-42032 will have a current sensor to prove running status. When current is nominal, “running” status shall be sent to the SCADA system.
   2. Supply fan SF-42033 will operate continuously to maintain 6 ACH.
      a. SF-42033 will have a current sensor to prove running status. When current is nominal, “running” status shall be sent to the SCADA system.
   3. Electric unit heater HT-42015 shall be controlled by a thermostat with adjustable set points. The heating set-point shall be 55 degrees Fahrenheit. When the temperature falls 5 degrees below the set point, the unit will energize. When the temperature rises 5 degrees above the set point, the unit will de-energize.

C. Electrical Room Control Sequences:
   1. Split System Heat Pump unit AHU-42030/ CDU-42030 will be controlled by a thermostat with adjustable set points. The cooling set point for AHU-42030/CDU-42030 will be 85 degrees Fahrenheit. When the temperature rises 3 degrees above the cooling set point, the unit will energize. When the temperature drops 3 degrees below the set point, the unit will de-energize. The heating set point for AHU-42030/ CDU-42030 will be 55 degrees Fahrenheit. When the temperature drops 3 degrees below the heating set point, the unit will energize. When the temperature rises 3 degrees above the heating set point, the unit will de-energize.
   2. Split System Heat Pump unit AHU-42031/ CDU-42031 will be controlled by a thermostat with adjustable set points. The cooling set point for AHU42031/CDU-42031 will be 85 degrees Fahrenheit. When the temperature rises 3 degrees above the cooling set point, the unit will energize. When the

temperature drops 3 degrees below the set point, the unit will de-energize. The heating set point for AHU-42031/ CDU-42031 will be 55 degrees Fahrenheit. When the temperature drops 3 degrees below the heating set point, the unit will energize. When the temperature rises 3 degrees above the heating set point, the unit will de-energize.

3. Room temperature detector (RTD) shall be provided in control room to monitor temperature inside the room. The information will be sent to SCADA.

PART 3 EXECUTION

3.01 PREPARATION

A. Before installation remove dust and debris from equipment and accessories.

B. During installation and until equipment is operated, protect equipment and accessories from dust and debris.

3.02 INSTALLATION

A. Install as indicated on the Drawings in accordance with NFPA 90A and the manufacturer's written instructions.

B. Coordinate installation of HVAC control systems with other trades.
   1. Prior to installation, coordinate wiring and conduit requirements with the electrical subcontractor.

C. Mount remote annunciator and test station on wall near smoke detector.
   1. Devices shall be easily accessible from floor level.
   2. Label annunciator and test station.

D. Provide electrical work to support smoke detector.
   1. Coordinate with electrical subcontractor.

E. Thermostat cable conduit installation:
   1. As specified in Section 26_05_00 - Common Work Results for Electrical, Section 26_05_18 - 600-Volt or Less Wires and Cables, and Section 26_05_33 - Conduits.

F. Sensor and control station mounting:
   1. Where not otherwise indicated, mount 5 feet above floor or walking level.
   2. Provide insulating back plates when mounting is on an exterior wall or a wall adjoining an unconditioned space.
   3. Shield outside thermostats or sensors from the sun. Provide thermostats with remote bulb and compensated capillary.
   4. Install locking covers where indicated on the Drawings.

3.03 TESTING

A. Test witnessing: Witnessed.

B. Test each control component and system as part of HVAC system testing, adjusting, and balancing as specified in Section 23_05_93 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

SECTION 23_31_13

METAL DUCTWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Metal ductwork.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   1. HVAC Systems-Duct Design.
   2. HVAC Duct Construction Standards, Metal and Flexible.

C. Underwriters Laboratories, Inc. (UL):
   1. 181A - Closure Systems for Use with Rigid Air Ducts.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Duct and component material and details of construction.
   2. System layout, including floor and wall penetrations.
   3. Supports and anchoring details.
   4. Components used in the duct system, including turning vanes, dampers, flexible connections, and access doors.

C. Shop Drawings.

1.04 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials:
   1. As specified in Section 01_60_00 - Product Requirements.

2. Ducts:
   a. Aluminum: Aluminum alloy 3003 H14 in accordance with ASTM B209.
3. Reinforcing: Formed or extruded angles matching ductwork material.

B. Changes in duct size:
   1. Use uniformly tapering sections.
   2. Taper not more than 1 inch in 5 inches of run unless otherwise indicated on the Drawings.

C. Bends: With the exception of miter bends, inside radii of bends to be equal to or greater than the largest duct dimension.

D. Existing conditions:
   1. Field verify existing dimensions, elevations, and conditions prior to Shop Drawing preparation and fabrication.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Pressure allowance:
   1. Sheet metal construction shall conform to a minimum pressure classification of 2 inches of water gauge, negative and positive pressure, unless otherwise indicated on the Drawings or specified.
   2. In accordance with the SMACNA HVAC Systems-Duct Design manual.
      a. Sheet metal thicknesses: The greater of the SMACNA design or:

Minimum Gauge (B&S) for 2-inch Water Gauge Static Pressure			
Diameter or Largest Dimension of Rectangular Duct (Inches)	**Galvanized Steel**	**Stainless Steel**	**Aluminum**
Up to 12	24	24	21
13, 14	22	22	20
15 to 18	20	20	18
19, 20	18	18	16
21 to 26	16	16	15
Larger than 27	14	14	13

      b. Spacing of hangers and supports:
         1) In accordance with SMACNA but no greater than that indicated on the Drawings.
         2) 8 feet on center for ducts 18 inches and smaller in the largest dimension.
         3) 4 feet on center to ducts over 18 inches in the largest dimension.
      c. Support connections:
         1) In accordance with SMACNA unless indicated on the Drawings.
         2) As a minimum, all support connections to metal or wood roofs at roof framing members only.
         3) No penetrations through roof deck, roof membrane, or connections to roof membrane.

2.03 COMPONENTS

A. Duct sleeves:
   1. Install where ducts pass through concrete or masonry walls and slabs.
   2. Size: 2 inches larger than the duct or duct with external insulation.
   3. Flanges: 4-inches wide.

B. Access openings:
   1. Install in locations for access to dampers, fusible links, controllers, and similar devices.
   2. Size: 2 inches less than duct size.
   3. Doors:
      a. Gauge not less than duct sheet.
      b. Provide continuous hinge and latch on outside.
   4. Gasket: Along door periphery.
   5. Visual panel: 1/8-inch thick, clear Plexiglas.

C. Turning vanes:
   1. Install at 90-degree bends.
      a. Square-turn elbows, smooth radius elbows, and splitters.
   2. Material: Same as ductwork.
   3. Type:
      a. Single-blade vanes for duct widths less than 36 inches.
      b. Airfoil type vanes for duct widths of 36 inches and greater:
         1) No trailing edge.
   4. Mounted in side rails.
   5. Size: 2-inch blades for ducts up to 18 inches, 4-1/2 inch blades for larger ducts.

D. Flexible connectors:
   1. Install at connections to air handling equipment and at other locations indicated on the Drawings.
   2. As specified in Section 23_05_00 - Common Work Results for HVAC.

E. Splitter dampers:
   1. Provide at branch take-offs where necessary for balancing the system.

2.04 FABRICATION

A. Fabricate ductwork to the configuration and outer dimensions indicated on the Drawings.

B. Ductwork specified with insulation to be sized as indicated on the Drawings. Do not increase duct dimensions by thickness of insulation when internal insulation is specified.

C. Do not utilize S clips, duct tape, or externally applied mastic on medium pressure duct systems.

D. Do not use snap lock seams.

2.05 SHIPPING

A. As specified in Section 01_60_00 - Product Requirements and Section 23_05_00 - Common Work Results for HVAC.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements and Section 23_05_00 - Common Work Results for HVAC.

3.02 INSTALLATION

A. Hangers:
   1. Install as indicated on the Drawings.
   2. When hangers are not detailed, conform to SMACNA HVAC Systems-Duct Design Manual standards and the following requirements:
      a. Rectangular ducts concealed in ceiling spaces:
         1) Use metal strap hangers.
         2) Fasten to sides of duct with 2 screws.
         3) Fasten to bottom of duct with 1 screw.
      b. Rectangular ducts in exposed areas:
         1) Install shelf angle trapeze hangers or Unistrut type hangers.
      c. Round ducts in exposed areas:
         1) Install 2 half-round bands with rods bolted to panels.

B. Provide closed-cell neoprene gaskets at flanged joints.

C. Tapes and mastics used to seal ductwork shall be listed and labeled in accordance with UL 181A and shall be marked.

3.03 FIELD QUALITY CONTROL

A. Inspect ductwork under operating conditions.
   1. Correct audible leaks and leaks that can be felt with the hand.

END OF SECTION

SECTION 23_31_17

FIBERGLASS REINFORCED PLASTIC DUCTWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fiberglass reinforced plastic (FRP) ductwork system.
      a. Ducts and fittings.
      b. Flexible connections.
      c. Expansion joints.
      d. Supports.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. RTP-1 - Reinforced Thermoset Plastic Corrosion-Resistant Equipment.

B. American Water Works Association (AWWA):
   1. M45 - Fiberglass Pipe Design.

C. ASTM International (ASTM):
   1. C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   2. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   3. D2105 - Standard Test Method for Longitudinal Tensile Properties of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube.
   4. D2344 - Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates.
   5. D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   6. D2992 - Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings.
   7. D2996 - Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
   8. D3982 - Standard Specification for Contact Molded “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Ducts.
   9. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. National Fire Protection Association (NFPA):
   1. 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids.

E. National Institute of Standards and Technology (NIST):
   1. PS 15 - Custom Contact-Molded Reinforced-Polyester Chemical Resistant Process Equipment.

F. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.03 SUBMITTALS

A. As specified in Section 01_33_00 - Submittal Procedures and Section 23_05_00 - Common Work Results for HVAC.

B. Shop Drawings:
   1. Scaled ductwork layout.
      a. Size, joint types, horizontal dimensions, and elevations.
      b. Support locations.
      c. External stiffeners and expansion joints locations.
   2. Fabrication details.
   3. Support, flexible connections, and external stiffeners.
      a. Materials and configuration.

C. Calculations:
   1. Wall thickness calculations based upon design criteria.
   2. Stresses and reaction loads at supports.

D. Manufacturer's installation instructions.
   1. Detailed instructions for field butt joints, including lay-up sequence, width of each reinforcement layer, and total number of layers.

E. Submit test results as specified in Section 06_80_15 - Fiberglass Reinforced Plastic, verifying that ductwork meets standards specified.
   1. Also as specified in Section 06_80_15 - Fiberglass Reinforced Plastic as to the requirements of FRP manufacturing and standard testing.
   2. If there is a conflict between this Section and Section 06_80_15 - Fiberglass Reinforced Plastic, the more stringent requirements shall govern.
      a. Test methods by the manufacturer shall be in accordance with ASTM 2996 and ASTM 2992 (buried pipe).

1.04 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

2.02 MANUFACTURERS

A. One of the following or equal:
   1. Daniel Mechanical.
   2. Engineered Composite Systems.
   3. NOV Fiber Glass Systems.
   4. Perry Fiberglass Products, Inc.

2.03 DESIGN AND PERFORMANCE CRITERIA

A. Ducting for odor control systems:
   1. Minimum internal pressure: 20.0 inches water gauge.
   2. Minimum internal vacuum: 20.0 inches water gauge.

B. Support spacing: As needed to comply with wall thicknesses calculations but not greater than the following:
   1. Contact-molded ductwork: Not greater than 5 foot centers.
   2. Filament-wound ducts: In accordance with SMACNA standards below:

Duct Inside Diameter (Inches)	Maximum Span (Feet)
3 to 19	10
20 to 29	15
30 to 35	20

C. Minimum flooding: Design ductwork for water accumulation as follows:
   1. Rectangular: 1 inch deep across bottom of duct.
   2. Round: 2 inches deep across bottom of duct.

D. Physical and mechanical properties: Duct shall meet the following standards:

Pipe Property	Standard	Design Properties	
		Hoop (PSI)	Axial (PSI)
Ultimate Flexural Stress	ASTM D2412	50,000	18,000
Flexural Modulus		3.05×10^6	1.0×10^6
Ultimate Tensile Stress	ASTM D2105	52,000	7,485
Tensile Modulus		1.5×10^6	1.56×10^6
Ultimate Shear Strength		Approximate Typical Values (PSI)	
Interlaminar	ASTM D2344	2,130 - 2,730	
Cross		15,000	
Density	ASTM D792	0.065 - 0.072 lb./In^3	

E. Design tensile stress:
   1. Calculations for design of wall thickness assume a laminate ultimate tensile stress of 9,000 pounds per square inch maximum.
   2. Decrease ultimate tensile stress as appropriate to the laminate design.
      a. Round ducting: Maximum allowable design tensile stress shall be the ultimate tensile stress divided by 5.
      b. Rectangular ducting: Maximum allowable design tensile stress shall be the ultimate tensile stress divided by 10.

F. Manufacturer shall provide design calculations for FRP ductwork design and construction. Calculations shall be signed and sealed by licensed engineer registered in the State of Washington.

2.04 DUCTWORK MATERIALS

A. As specified in applicable portions of Section 06_80_15 - Fiberglass Reinforced Plastic.

B. Minimum corrosion liner:
   1. Interior surfacing “C” or Nexus veil as specified for the service environment.
   2. Exterior surfacing: “C” or “A” veil.
   3. Remainder 1-1/2 ounce per square foot mat to total minimum thickness of 0.096 inches on surface exposed to the service environment.
   4. Duct shall be resistant to the following in accordance with ASTM C582:

Sulfuric Acid	75 percent	At 100 degrees Fahrenheit
Nitric Acid	20 percent	At 100 degrees Fahrenheit
Sodium Hydroxide	50 percent	At 100 degrees Fahrenheit
Hydrofluoric Acid	20 percent	At 100 degrees Fahrenheit

C. Ultraviolet stabilizer:
   1. Exposed external surfaces of FRP ductwork installed outdoors shall be provided with protection against ultraviolet degradation and weather erosion.
   2. Duct shall carry the flame spread rating of 25 or less in accordance with ASTM E84 and a smoke contribution rating in excess of 1,000 in accordance with NFPA 91.
   3. External duct protection shall be provided by an ultraviolet stabilizer added to the final coat or resin that also incorporates paraffin wax curing elements and color pigment.
   4. An alternative system to polyurethane paint with color pigments may be used if approved by the Owner’ designated representative.

D. Resin:
   1. External surface and structural layers of FRP ductwork shall carry a flame spread rating of 25 or less in accordance with ASTM E84 and a smoke contribution of 50 or less in accordance with NFPA 91.
   2. Premium vinyl ester as follows unless otherwise recommended by the resin manufacturer for the service environment:
      a. For structural layers: With sufficient antimony trioxide or pentoxide for Class I fire rating.

b. Manufacturers: One of the following or equal:
   1) Ashland, Hetron 992FR.
   2) Reichhold Dion, VER 9300FR.

E. Color: Add pigment to the exterior surface resin coat such that the color of the duct will be similar to paint used for equipment, except that ducting for air conditioning systems which are concealed above suspended ceilings need not be pigmented.
   1. Selected by the Owner.

F. Provide fasteners, field joints, expansion joints, and supports required for complete installation of a duct system.

G. Flanges:
   1. Hand laid up to the thickness specified in accordance with ASTM D3982.
   2. FRP flanges shall be made of the same materials as the FRP ductwork.
   3. Flange bolt hold pattern as well as flange dimensions, shall be in accordance with NIST PS 15 Tables 2 and 5 for duct and pipe, respectively, except for thickness. Thickness of flange shall be a minimum of 1/2 inch.
   4. Manufactured using the hand lay-up technique and shall be integral to the duct in accordance with ASME RTP-1. Filament-wound and/or random chopped methods of constructing flanges will not be acceptable.

Pipe Diameter (Inches)	Minimum Flange Thickness (Inches)
Less Than 12	1/2
12 to 24	1/2
25 to 41	5/8
42 to 60	3/4

2.05 DUCTWORK FABRICATION

A. Hand lay-up or filament wound construction as specified in Section 06_80_15 - Fiberglass Reinforced Plastic.
   1. Provide wall thickness necessary to comply with design criteria but not less than the following minimum thicknesses.
   2. Structural wall thicknesses shall not include the thickness of the interior corrosion barrier, inner surface, and interior layer:

Duct Size	Round Ducting (Wall Thickness, Inches)	Rectangular Ducting (Wall Thickness, Inches)	Buried Ducting (Wall Thickness, Inches)
For 18 inch and smaller ducts	0.1875	0.25	0.34
20 to 36 inch ducts	0.25	0.375	0.42
42 to 54 inch ducts	0.375	0.500	0.60
60 to 72 inch ducts	0.438	0.625	0.625

B. Fittings:
   1. Type: Hand lay-up contact molded.
   2. Resin: Identical to and with same strength as resin used for FRP ductwork.
   3. Wall thickness: At least equal to the thickness of the thickest adjacent ducting.
   4. Internal diameter: Equal to the adjacent duct.
   5. Tolerance:
      a. Angles for fittings shall be within:
         1) 1 degree for up to 30-inch diameter duct.
         2) 1/2 degree for over 30-inch diameter and above duct.
   6. Round standard elbows:
      a. Centerline radius shall be equal to 1-1/2 times the diameter unless otherwise indicated on the Drawings.
      b. Up to 24-inch diameter: Smooth radius elbows.
      c. 26-inch diameter and greater: May be mitered sections as follows:
         1) 0- to 44-degree elbows: 1 mitered joint and 2 sections.
         2) 45- to 80-degree elbows: Minimum of 2 mitered joints and 3 sections.
         3) Elbows greater than 80 degrees: Minimum of 4 mitered joints and 5 sections.
      d. Provide turning vanes in round mitered elbows. Round elbow turning vanes shall be of FRP construction, solid or double wall construction with an airfoil shaped profile.
   7. Rectangular elbows:
      a. Fittings shall be factory manufactured to meet the specified design criteria and in accordance with approved Submittals. Factory install reinforcing ribs as required to meet the specified deflection requirements and to provide a system free from pulsing, warpage, sagging, and undue vibration.
      b. Provide turning vanes in rectangular elbows.
         1) Shall be of FRP construction, solid or double wall construction with an airfoil shaped profile.

C. Joints:
   1. Flanged:
      a. In accordance with ASTM D3982 and bolt hold patterns in accordance with NIST PS 15, Table 2.
      b. Flanged joints shall be provided at the following locations:
         1) At each damper and each item of equipment to facilitate disassembly.
         2) At each change in material.
         3) Where indicated on the Drawings.
      c. Gaskets for flanged joints: 1/8-inch neoprene over full flange face.
      d. Bolt nuts and washers: Type 316 stainless steel.
   2. Butt and strap welded:
      a. Field joints shall be provided at the following locations:
         1) 12 inches from any increasing or decreasing cross-section of pipe.
         2) Where the pipe to be joined has the same diameter.
      b. Thickness of joint overlays: At least equal to the thickness of the thickest adjacent duct.
      c. Field weld kits:
         1) Necessary fiberglass and reinforcing material shall be supplied pre-cut and individually packaged for each joint.
         2) Bulk glass rolls will not be acceptable.

2.06 FLEXIBLE CONNECTIONS

A. Shall be provided as indicated on the Drawings. When not shown, they shall be provided at duct to rotating equipment connections.

B. FL-3, duct to equipment heavy duty flexible connection:
   1. Materials: EPDM rubber vulcanized with minimum of 1 ply of reinforcing fabric; 3/16 inch thick.
   2. Unit shall have minimum movement of:
      a. Axial compression: 2.25 inches.
      b. Axial extension: 1.25 inches.
      c. Lateral offset: 1.25 inches.
   3. Provide 3/8 inch thick by 2 inch wide pre-drilled retaining rings/back-up bars to clamp the expansion joints into the ducting system.
   4. Expansion joint shall be of fully molded construction. Splices will not be allowed in the body of the expansion joint.
   5. Manufacturers: One of the following or equal:
      a. Holz Rubber, Style 952 Arch Design Expansion Joint.
      b. Proco Series 500, Style 530 Fabric Fan Connector.

2.07 EXPANSION JOINTS

A. Provided as indicated on the Drawings. When not shown, they shall be provided in above grade duct at maximum spacing of 40-foot centers.

B. Construction:
   1. Body: EPDM.
   2. Reinforcing: Multiple layers (2 minimum) of impregnated polyester or Kevlar tire cord fabric.
   3. Flange rings: Type 316 stainless steel or minimum 3/4-inch thick FRP.
   4. Hardware/Fasteners: Type 316 stainless steel.
   5. Minimum pressure rating: 1 pound per square inch.
   6. Minimum vacuum rating: 1 pound per square inch.
   7. Minimum operating temperature: 175 degrees Fahrenheit.
   8. Connections: Flanged in accordance with NIST PS 15, Table 2.
   9. Seamless construction built as on continuous piece. Wrapped, seamed, or spliced type expansion joints are not acceptable.
   10. Provide Type 316 stainless steel control rods.

C. Minimum movement:
   1. Axial compression: 2.25 inches.
   2. Axial extension: 1.25 inches.
   3. Lateral offset: 1 inch.

D. Manufacturers: One of the following or equal:
   1. Daniel Co., DanFLEX Model 101.
   2. Mercer Rubber Co., Model ME for Rectangular, Model MI-9 for Round.

2.08 DUCT SUPPORTS

A. Provide duct supports as indicated on the Drawings.

B. Protect the duct from clamping force of strap hangers with a 1/8-inch thick layer of neoprene pad.

C. When anchors are required, they shall be externally bonded to the duct. Drive screws or other penetrations of the duct linter are not permitted.

D. When not indicated on the Drawings, provide supports and seismic bracing in accordance with the SMACNA design manual.

2.09 SHOP INSPECTION

A. Each load of FRP duct or pipe shall be shop inspected during fabrication and prior to shipment.
   1. Conducted by qualified third-party inspectors that have extensive experience in the design, manufacture, testing, and installation of FRP duct and pipe.
   2. Cost for third-party inspection shall be borne by the manufacturer.
   3. Name, resume, and qualifications of the third-party inspector shall be submitted to the Engineer for approval.
      a. Acceptable inspection engineers shall be one of the following or equal:
         1) FEMech Engineering.
         2) Fiberglass Structural Engineers, Inc.

2.10 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

3.02 INSTALLATION

A. Ductwork shall be fabricated and erected where indicated on the Drawings or as specified in this Section.
   1. Rigidly supported and secured in an approved manner.

B. Install ductwork parallel to walls and/or roof and vertically plumb.

C. Bracing and vibration isolators shall be installed, where necessary, to eliminate vibration, rattle and noise.
   1. Hangers shall be installed plumb and securely suspended from supplementary steel or inserts in concrete slabs.

2. Lower ends of hanger rods shall be sufficiently threaded to allow for adequate vertical adjustment.
3. Building siding and metal decking shall not be used to hang ductwork.

D. Contractor shall not install any equipment or materials until the Owner's designated representative has approved all Submittals. If any equipment or materials are installed prior to approval of the Submittals, it shall be at the Contractor's risk.

E. Wherever ducts are divided, the cross-sectional area shall be maintained. All such changes must be approved and installed as directed by the Owner's designated representative or as approved on Shop Drawings or erection drawings.

F. Do not remove or alter factory installed duct reinforcing ribs, except as required to accommodate duct alterations due to unexpected field conditions.
1. Notify the Owner's designated representative prior to starting any field modifications involving ductwork structural reinforcing members.
2. Submit additional design calculations to demonstrate structural design integrity of ductwork and fittings requiring reinforcing modifications in the field.

G. Direct buried duct:
1. Grade trench so it will be 1.5 times wider than the diameter of the duct.
2. Fill bottom of trench with a minimum of 6 inches of back fill (sand or pea gravel).
3. Slope trench with a 1/8 inch per foot pitch back to the start of the system.
4. Backfill in 6 inches lift increments compacting 80 to 90 percent.
5. A minimum of 4 inches of backfill overtop the duct system is required.
6. Follow the manufacturer's burial procedures.

H. No ductwork or components shall be shipped prior to complete resin cure.

I. Cover ductwork openings with tape, plastic, or sheet metal to reduce the amount of dust or debris which may collect in the system at each of the following times:
1. At the time of rough installation.
2. During storage on the construction site.
3. Until final start-up of the heating and cooling equipment.

J. Before installation remove dust and debris from ducts.

K. Install products in accordance with Shop Drawings and the manufacturer's instructions. Drawings indicate general routing only and shall be modified as necessary.

END OF SECTION

SECTION 23_34_01

FANS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fans, motors, and accessories.

1.02 REFERENCES

A. Abbreviations:
   1. As used in this Section and on the Drawings, abbreviations and Fan Schedule headings have the following meaning:
      a. EF or EXF: Exhaust fan.
      b. Hp: Fan motor horsepower.
      c. SF or SPF: Supply fan.
      d. Size: Nominal fan blade or wheel diameter in inches.
      e. SP or ESP: Fan external static pressure in inches water column.
      f. Type: Fan type as specified in this Section.
      g. V/Ph: Fan motor voltage and power phases.

B. Standards:
   1. Air Movement and Control Association International, Inc. (AMCA).
   2. American Bearing Manufacturers Association (ABMA):
      a. 9 - Load Ratings and Fatigue Life for Ball Bearings.
      b. 11 - Load Ratings and Fatigue Life for Roller Bearings.
   3. ASTM International (ASTM):
      a. A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      b. D4167 - Standard Specification for Fiber Reinforced Plastic Fans and Blowers.
      c. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   4. National Fire Protection Association (NFPA):
      a. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   5. National Roofing Contractors Association (NRCA).
   6. Occupational Safety and Health Administration (OSHA).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Roof coordination as specified in Section 23_05_00 - Common Work Results for HVAC.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Materials.
   2. Primary and ancillary equipment.
   3. Sound power level in each of 8 octave bands and overall sones.
   4. Fan system layout, mechanical, electrical power, and control diagrams.
   5. Supports, vibration isolators, and seismic bracing calculations and details.
   6. Calculated fan vibration levels and field-testing method.
   7. Bearing life.
   8. Fan performance curves showing specified operating condition.

C. Drawings:
   1. Component layout and identification.
   2. Views:
      a. Front, side, rear elevations, and top and bottom views, with dimensions.
      b. Connection locations, including electrical, mechanical, and other.
   3. Cut away drawings.
      a. Parts list.
      b. Material specification lists.
   4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.
   5. Details for supports, isolators, and bracing.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria.
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

E. Manufacturer’s recommendations for handling, storage, and installation.

F. Nameplate data.

G. Vendor operation and maintenance manuals: Manufacturer’s standard instruction manual for operation and maintenance.

H. Provide manufacturers reports on factory testing.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 23_05_00 - Common Work Results for HVAC.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 23_09_13 - Instrumentation and Control Devices for HVAC.

2.03 TYPE 7, SQUARE IN-LINE CENTRIFUGAL FANS

A. Manufacturers: One of the following or equal:
   1. Greenheck, Model BSQ.
   2. Loren Cook, similar series.
   3. Penn, similar series.

B. Characteristics:
   1. Square, in-line centrifugal type.
   2. Backward-inclined, non-overloading, aluminum wheel; statically and dynamically balanced.
   3. Housing: Square type with duct transitions to match fan supplied; galvanized steel or aluminum as scheduled, minimum 20-gauge panels with 10-gauge stiffeners and frame as required.
   4. Motor: Mounted on exterior of housing for belt drive units.
   5. Finishes: Provide 2-coat finish with a 2.0 to 3.0-mils thick epoxy primer base coat and 2.0 to 3.0-mils thick polyester powder coated topcoat or approved equal finish on fan and accessories.

C. Accessories:
   1. Mounting base: Galvanized steel or aluminum; match scheduled casing material.
   2. Mounting brackets: Necessary for installation.
   3. Provide other accessories as scheduled.

2.04 TYPE 13, BASE MOUNT CENTRIFUGAL FANS

A. Manufacturers: One of the following or equal:
   1. Greenheck Fan Corp., Model USF.
   2. Loren Cook, similar series.
   3. Penn, similar series.

B. Characteristics:
   1. Roof-mounted.
   2. Backward inclined single width, performance as scheduled.
   3. Materials: Aluminum fan, housing, and accessories.
   4. Motor characteristics: As scheduled.

5. Motor:
    a. Permanently lubricated bearings.
    b. Mounted on vibration isolators.
    c. Bearing life:
        1) Minimum L-10 bearing life shall be 200,000 hours in accordance with ABMA 9 or ABMA 11.
6. Housing and bearing supports: Welded structural members.
7. Finishes: Provide 2-coat finish with a 2.0 to 3.0-mils thick epoxy primer base coat and 2.0 to 3.0-mils thick polyester powder coated topcoat or approved equal finish on fan and accessories.

2.05 SOURCE QUALITY CONTROL

A. Factory test fans listed on the Fan Schedule for proper operation, performance, and electrical controls.

2.06 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

B. Deliver units in 1 piece, factory assembled, internally wired, and lubricated.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

3.02 PREPARATION

A. Anchoring and bracing to structures:
    1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
    2. Install anchors of type and material indicated on approved anchoring designs.
    3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

3.04 TESTING

A. Test equipment performance and balance equipment as specified in Section 23_05_93 - Testing, Adjusting, and Balancing for HVAC.

3.05 FIELD QUALITY CONTROL

A. Verify equipment operation and unit vibration is within the manufacturer's submitted maximum.

3.06 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

SECTION 23_81_44

HEAT PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Mini-split systems.

1.02 REFERENCES

A. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   1. Standard 62.1 - Ventilation for Acceptable Indoor Air Quality.

B. Federal Specification (FS):
   1. Standard 141 - Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling and Testing.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Roof Coordination:
   1. As specified in Section 23_05_00 - Common Work Results for HVAC.

1.04 DELEGATED DESIGN SUBMITTALS

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Catalog cuts, bulletins, and brochures:
   1. Design features.
   2. Load capacities.
   3. Efficiency ratings.
   4. Dimensions.
   5. Weight: Shipping and operating.

C. Drawings:
   1. Component layout and identification.

2. Views:
    a. Front, side, rear elevations, and top and bottom views, with dimensions.
    b. Connection locations including electrical, mechanical, and other.
3. Cut away drawings.
    a. Parts list.
    b. Material specification lists.
4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.
5. Details for supports, isolators, and bracing.

D. Delegated Design Submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria.
    a. For equipment installed outdoors.

E. Engineering data:
1. Manufacturer's published data for compressor, evaporator coil, condenser, evaporator fan, refrigerant, and filter.
2. Maximum equipment vibration levels and field-testing method.
3. Sound power level in each of 8 octave bands and overall Sones.
4. Fan performance curves showing specified operating condition.
5. Bearing life.

F. Manufacturer's recommendations for handling, storage, and installation.

G. Nameplate data.

H. Seismic certification.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

B. Special warranties:
1. Refrigerant compressors and closed or sealed refrigerant systems warranty duration: Provide 5-year warranty.
2. Evaporator and condensing coils warranty duration: Provide 5-year warranty.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

B. Supplied components of the unit shall be furnished and fully integrated by the unit system supplier:
   1. Furnish and install piping, valves, dampers, sensors, and wiring within the unit package.
   2. Provide a prewired, unit mounted control panel to dampers and sensors within the unit.

C. Motors:
   1. Totally enclosed.
   2. Voltage and number of phases as scheduled.
   3. Compressor motors:
      a. Cooled by refrigerant gas passing through windings.
      b. Provided with line break thermal and current overload protection.
   4. Fan and blower motors:
      a. Permanently lubricated ball bearings.
      b. Integral automatic reset thermal overload protection.

D. Electrical:
   1. Provide a single conduit connection in the unit for both power and control wiring.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. As specified in Section 23_05_00 - Common Work Results for HVAC.

B. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 23_09_13 - Instrumentation and Control Devices for HVAC.

2.03 MINI-SPLIT SYSTEM HEAT PUMPS

A. Manufacturers: One of the following or equal:
   1. Mitsubishi, Series PUZ; when indoor air handling unit scheduled, PLA (ceiling recessed cassette).
   2. Samsung, similar series.
   3. Daikin, similar series.

B. Compressors:
   1. Fully hermetically-sealed, high-efficiency, reciprocating or rotary or scroll-type, with rubber grommet vibration isolation.

C. Fans:
   1. Indoor air fan:
      a. Direct driven with capacitor start motor; double inlet, forward curve sirocco fan, steel with corrosion resistant finish, statically and dynamically balanced.
      b. Bearings: Permanently sealed ball bearing type and permanently lubricated.
   2. Outdoor condenser fan:
      a. Propeller type, direct drive, aluminum blades, dynamically balanced.
      b. Bearings: Permanently sealed ball bearing type and permanently lubricated.

D. Coils:
   1. Evaporator and condenser coils: Seamless copper tubes with mechanically bonded aluminum plate fins.
   2. Provide corrosion resistant finish, suitable for marine environment.

E. Refrigerant components: Refrigerant circuit including:
   1. Accumulator and filter/drier.
   2. Expansion device.
   3. Reversing valve.
   4. Flow control valves.
   5. Service and gauge connections on compressor suction and discharge, and liquid lines to charge, evacuate, and contain refrigerant.

F. Controls and equipment safety features:
   1. Provide system controls for a complete functioning system:
      a. High and low evaporator fan speed control for cooling and heating modes.
      b. Fan only operation.
      c. Space temperature condition setting.
      d. Vapor bellows thermostat to cycle unit to maintain space condition.
   2. Equipment safety features:
      a. Thermostatic base pan drain to prevent freeze up of the fan in collected condensate.
   3. Provide with a low ambient cooling option.

G. Unit casing:
   1. Slide-out design unit casing manufactured of high strength molded plastic with smooth finish and outdoor casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, polyester powder coating for corrosion protection.
   2. Weatherproof design, reinforced and braced for maximum rigidity.
   3. Provided with:
      a. Filter rack for filters accessible through the bottom of the unit.
      b. Non-corrosive drain pan in accordance with ASHRAE Standard 62.1.
      c. Horizontal drain connection.
      d. Provide mini condensate pump suitable to be powered from indoor/outdoor unit.
      e. Knockouts for power connections.
      f. Provide wall sleeve of galvanized steel coated similar to unit casing.

2.04 ACCESSORIES

A. Sensors: As specified in Section 23_09_13 - Instrumentation and Control Devices for HVAC.

B. Provide hail guard to protect against damage from hail and other flying debris.

C. Provide coil guard grill to protect condenser coil from penetration by large objects.

2.05 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 23_05_00 - Common Work Results for HVAC.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Insulate refrigerant and condensate piping as specified in Section 23_05_00 - Common Work Results for HVAC.

3.04 TESTING

A. Test equipment performance and balance equipment as specified in Section 23_05_93 - Testing, Adjusting, and Balancing for HVAC.
   1. Test for outdoor sound power at levels.

3.05 FIELD QUALITY CONTROL

A. Verify equipment installation operation and vibration is within the manufacturer’s submitted maximum.

3.06 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

SECTION 23_83_01

HEATING UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for electric, gas fired, steam, hot water unit heaters and thermostats for heaters.

1.02 REFERENCES

A. American Gas Association (AGA).

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

C. Underwriters' Laboratories, Inc. (UL).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Roof coordination as specified in Section 23_05_00 - Common Work Results for HVAC.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Catalog cuts, bulletins, and brochures:
   1. Design features.
   2. Load capacities.
   3. Efficiency ratings.
   4. Dimensions.
   5. Weight: Shipping and operating.

C. Drawings:
   1. Component layout and identification.
   2. Views:
      a. Front, side, rear elevations, and top and bottom views, with dimensions.
      b. Connection locations including electrical, mechanical, and other.

3. Cut away drawings:
    a. Parts list.
    b. Material specification lists.
4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.
5. Details for supports, isolators, and bracing.

D. Engineering data:
1. Manufacturer's published data for fan, burner, and filter.
2. Maximum equipment vibration levels and field-testing method.
3. Sound power level in each of 8 octave bands and overall Sones.
4. Fan performance curves showing specified operating condition.
5. Bearing life.

E. Manufacturer's recommendations for handling, storage, and installation.

F. Nameplate data.

G. Seismic certification.

H. Vendor operation and maintenance manuals: Manufacturer's standard instruction manual for operation and maintenance.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. As specified in Section 23_05_00 - Common Work Results for HVAC.

B. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 23_09_13 - Instrumentation and Control Devices for HVAC.

2.03 ELECTRIC UNIT HEATER (EUH)

A. Manufacturers: One of the following or equal:
1. Indeeco, Type TRIAD.
2. Trane.
3. Markel.
4. Chromalox.

B. Fan type: Aluminum axial flow:
   1. Provide fan guards.
   2. Dynamically balance.
   3. Fan designed for quiet operation.
   4. Permanently lubricated ball bearings.
   5. Automatic reset thermal overload protection.

C. Heating element characteristics:
   1. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
   2. Fin type, Type 316 stainless steel plated heater elements, with elements brazed to common fins, designed for maximum strength and maximum heat transfer.
   3. 3-phase designed for balanced phases.
   4. Over temperature cutout with automatic reset.

D. Features:
   1. Built-in magnetic contactors.
   2. Control transformer for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.
   3. Required mounting brackets.
   4. Individually adjustable outlet louvers.
   5. Heavy 16 gauge stainless steel louvered outlet grille and plated rear grille.
   6. Cabinet formed of minimum thickness 18-gauge steel with steel stiffeners. Listed for corrosive areas and NEMA 4X hose down requirements.
   7. Controls:
      a. Provide thermostat as specified in this Section.
      b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.

E. Finishes:
   1. Casing finish backed enamel in manufacturer's standard color.

2.04 THERMOSTATS FOR UNIT HEATERS

A. Type: Wall mounted, heat only with fan AUTO-ON selector switch when fan part of unit and separate system ON-OFF selector switch.

B. Dial or lever temperature setpoint adjustment with 45 to 90 degrees Fahrenheit setpoint range.

C. Setpoint and temperature indication.

D. Control voltage as indicated in the Heating Unit Schedules.

E. Bi-metallic contacts suitable for 1- or 2-stage unit heater control as specified for the heater size or as scheduled.

2.05 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 23_05_00 - Common Work Results for HVAC.

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

3.04 TESTING

A. Test equipment performance and balance equipment as specified in Section 23_05_93 - Testing, Adjusting, and Balancing for HVAC.

3.05 FIELD QUALITY CONTROL

A. Verify equipment operation is within manufacturer's standards and that noise levels do not exceed levels specified.

3.06 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

CITY OF BELLINGHAM, WASHINGTON

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

CITY PROJECT NO. EU-194
BID NUMBER 3B-2026

CONTRACT AND TECHNICAL SPECIFICATIONS

BID DOCUMENTS

VOLUME 2 OF 2

JANUARY 2026

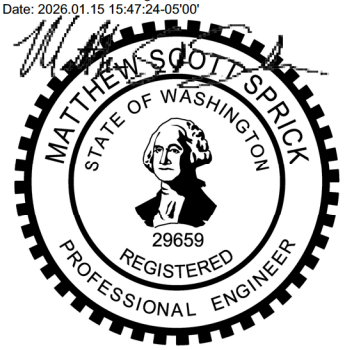
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PRIMARY SLUDGE TANK REPLACEMENT

CONTRACT AND TECHNICAL SPECIFICATIONS

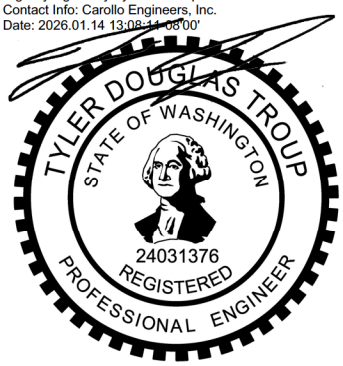
ENGINEER CERTIFICATION

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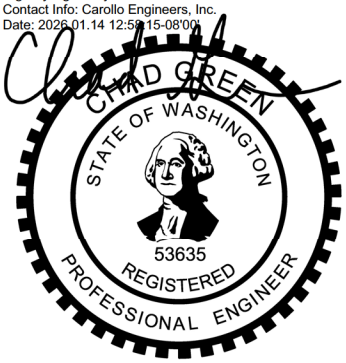
Matthew S. Sprick, Carollo Engineers
Divisions 01, 10, 40 (except 40_61_00, 40_61_15, 40_61_16.10, 40_64_01, 40_66_01, 40_67_01, 40_67_26, 40_71_15, 40_71_43, 40_71_79, 40_72_24, 40_72_76, 40_73_13, 40_73_23, 40_73_36, 40_73_63, 40_73_64, 40_75_59, 40_80_01, 40_96_15)
41, 43, 46
Sections 09_96_01, 31_00_00, 31_05_15, 31_10_00, 31_23_19, 31_23_24, 31_23_35, 31_50_00, 33_05_61.02

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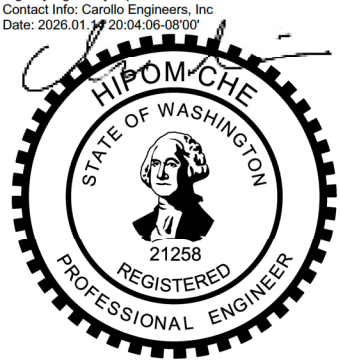
Tyler Troup, Carollo Engineers
Divisions 26, 28
Sections 40_61_00, 40_61_15, 40_61_16.10, 40_64_01, 40_66_01, 40_67_01, 40_67_26, 40_71_15, 40_71_43, 40_71_79, 40_72_24, 40_72_76, 40_73_13, 40_73_23, 40_73_36, 40_73_63, 40_73_64, 40_75_59, 40_80_01, 40_96_15

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Section 08_91_00

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Hipom Che, Carollo Engineers
Divisions 03, 05, 06, 07 (except 07_22_70, 07_54_23, 07_60_00)
Sections 08_11_13, 08_11_17, 08_71_00, 08_80_00, 09_22_17, 31_63_17, 31_63_14

CITY OF BELLINGHAM, WASHINGTON

PRIMARY SLUDGE TANK REPLACEMENT

CONTRACT AND TECHNICAL SPECIFICATIONS

ENGINEER CERTIFICATION



Tim Faber, King Architecture, LLC
Sections 07_22_00, 07_54_23, 07_60_00

KING
ARCHITECTURE

CITY OF BELLINGHAM, WASHINGTON

PRIMARY SLUDGE TANK REPLACEMENT

CONTRACT AND TECHNICAL SPECIFICATIONS

ENGINEER CERTIFICATION



1/14/2026

Paul Thomas, Wilson Engineering
Sections 31_25_14, 31_32_18.04, 32_01_15, 32_12_15, 32_16_13, 32_90_01, 33_41_00

WILSON ENGINEERING

CITY OF BELLINGHAM
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COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for electrical:
      a. Basic design and performance criteria.
      b. Prescriptive requirements for common components.
      c. Installation.

B. Contract Drawings:
   1. Schematic diagrams:
      a. Controls are shown as de-energized.
      b. Add relays, where required, to provide necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
      c. Mount devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted.
   2. Plan drawings:
      a. Electrical drawings show desired locations, arrangements, and components of the electrical Work in a diagrammatic manner.
      b. Locations and sizes of equipment are approximate only.
   3. Installation details:
      a. Contract Drawings include typical installation details the Contractor is to use to complete the electrical Work. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the Engineer.
      b. Not all typical installation details are referenced within the drawing set. Apply and use typical details where appropriate.

1.02 REFERENCES

A. Abbreviations:
   1. FAT: Factory acceptance test that is also referred to as source test.
   2. ICSC: Instrumentation and controls subcontractor.
   3. PCIS: Process control and instrumentation system.

B. Standards:
   1. American National Standards Institute (ANSI).
   2. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   3. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. LCP: Local control panel: Operator interface panel that may contain pilot type control devices, operator interface devices, control relays, etc., and does not contain a PLC or RIO.
   2. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
   3. Space: Portion of a switchgear, motor control center, panelboard, switchboard, or control panel that does not physically contain a device but is capable of accepting a device with no modifications to the equipment.
      a. Furnish hardware to accommodate installation of future circuit breakers, instruments, relays, and controls.
      b. Wire relay and circuit breaker control power and network connections to the compartment and provide terminations.
      c. Space for future devices shall include:
         1) All necessary bus.
         2) Device supports and mounting equipment.
         3) Device connections to bus work.
         4) Wire troughs or raceway space.
   4. Spare: Portion of a switchgear, motor control center, panelboard, switchboard, or control panel that physically contains a device with no load connections to be made.
   5. Unequipped space: Portion of a switchgear, motor control center, panelboard, switchboard, or control panel that does not physically contain a device, standoff, bus, hardware, or other equipment.
   6. Vendor control panel (VCP): Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.

1.04 DELEGATED DESIGN

A. Requirements for Delegated Design are specified in the Technical Sections.

1.05 QUALITY ASSURANCE

A. General:
   1. Furnish equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping precautions:
   1. After completion of shop assembly and successful factory testing, pack equipment in protective crates, and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
   2. Place dehumidifiers, when required, inside the polyethylene coverings.
   3. Skid-mount the equipment for final transport.

4. Provide lifting rings for moving without removing protective covering.
5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Loop drawings:
      a. Provide electrical information required in the preparation of loop drawings, including, but not limited to:
         1) Conduit numbers and associated signal(s) contained within each conduit.
         2) Wire numbers.
         3) Equipment terminal numbers.
         4) Junction boxes and signal(s) contained within each junction box.
         5) Equipment power sources, and associated circuit numbers.
         6) As-built drawings detailing wiring.
   2. Roof penetrations:
      a. Show roof penetrations for electrical equipment and conduit on the roof drawing Submittal and include equipment information:
         1) Type.
         2) Size.
         3) Location.
         4) Configuration of individual penetrations or large penetrations for multiple conduits.
         5) Weight.
         6) Anchoring and support details.

B. Meetings:
   1. As specified in Section 01_31_19 - Project Meetings.

C. Sequencing and scheduling:
   1. Equipment anchoring: Project construction schedule must include an event for obtaining the anchor layout drawings from equipment manufacturers in adequate time for templates to be constructed and anchors to be cast-in-place.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide field wiring and terminations.

B. Equipment mounting and anchoring:
   1. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load specified in

Section 01_81_50 - Design Criteria, and other loads as required for proper operation of equipment.

a. For equipment with an operating weight of 400 pounds or greater and equipment that is supported higher than 4 feet above the floor, provide calculations for:
    1) Operating weight and location of the centroid of mass for the equipment.
    2) Forces and overturning moments.
    3) Shear and tension forces in equipment anchorages, supports, and connections.
    4) Design of equipment anchorage, supports, and connections based on calculated shear and tension forces.

2. Anchorage of equipment to concrete or masonry:
    a. Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
    b. Unless otherwise indicated on the Drawings, select and provide anchors from the types specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.
    c. Provide bolt sleeves around cast-in anchor bolts for 400 pounds or greater equipment.
        1) Adjust bolts to final location and secure the sleeve.
3. Anchorage of equipment to metal supports:
    a. Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.

2.02 MATERIALS

A. Enclosures:
    1. Provide enclosures for electrical, instrumentation, and control equipment, regardless of Supplier or Subcontractor furnishing the equipment, that meet the requirements of NEMA Standard 250.
        a. Provide metallic enclosures unless specifically indicated otherwise.

B. Stainless steel:
    1. Where stainless steel is indicated or used for any portion of the electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
    2. Provide exposed screws of the same alloys.
    3. Use stainless steel hardware, when chemically compatible, in all chemical areas or areas requiring NEMA Type 4X construction.
    4. Do not use stainless steel in any area containing chlorine, gas or solution, chlorine products or ferric chloride.

C. Plant area electrical work requirements:
    1. Provide electrical materials in accordance with the following table, unless otherwise specifically indicated on the Drawings:
        a. Conduit installation requirements: As specified in Section 26_05_33 - Conduits.

Table 1. Electrical Material Requirements				
Plant Area	**Environment: W = Wet D = Damp C = Clean/dry X = Corrosive H = Hazardous**	**NEMA Enclosure Type**	**Exposed Conduit Type (as specified in Section 26_05_33 - Conduits)**	**Support Materials**
050 Tunnel/Gallery	D, X	4X 316 SST	PCS	316 SST
320 Hypochlorite Generation Building Electrical Room	C	1, 12	GRC	GALV STL
340 Secondary Sludge Pump Station Electrical Room	C	1, 12	GRC	GALV STL
420 Sludge Storage Building Electrical Room	C	1, 12	GRC	GALV STL
420 Sludge Storage Building Storage Room	C	12	GRC	GALV STL
420 Sludge Storage Building Basement Pump Room	D, X	4X 316 SST	PCS	316 SST
440 Sludge Storage Tanks, Odor Control System	W, X, H	4X 316 SST	PCS	316 SST
530 Solids Handling Facility East Ground and Upper Levels	W, X	4X 316 SST	PCS	316 SST
530 Solids Handling Facility East Basement/Below Grade Level	D, X	4X 316 SST	PCS	316 SST
Outdoor Areas Not Defined Above	W, X	4X 316 SST	PCS	316 SST
Notes: (1) Outdoor classified areas require dual rating of NEMA 4X and 7.				

PART 3 EXECUTION

3.01 EXAMINATION

A. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
   1. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before starting any Work.
   2. Determine information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
   3. Provide and document interface with, modifications to, upgrades, or replacement of existing circuits, power systems, controls, and equipment.

3.02 INSTALLATION

A. Demolition:
   1. As specified in Technical Sections or as indicated on the Drawings.
   2. Remove and dispose of conduit, wire, electrical equipment, controls, etc., associated with the items and/or areas to be demolished as indicated on the Drawings unless otherwise indicated.
   3. Salvage electrical equipment as specified in Section 01_35_21 - Selective Alterations and Demolition.
   4. For each piece of equipment to be removed, remove ancillary components (e.g., instruments, solenoid valves, disconnect switches, etc.).
   5. Conduit:
      a. Where conduit removal, other than associated with equipment to be removed, is indicated on the Drawings:
         1) Remove exposed conduit to the point of encasement or burial.
         2) Cut conduit flush and plug or cap encased or buried conduit.
      b. Where conduits are to remain in place and removal is not indicated on the Drawings:
         1) Cap conduit open ends.
         2) Re-label empty conduits as spare.
   6. Remove wire back to the source for conduits to be removed or abandoned in place.
   7. Provide new nameplates for modified electrical distribution equipment, motor control centers etc., to identify equipment and circuits that are no longer used as spares.
   8. Provide new typewritten schedules for modified panelboards.

B. Equipment:
   1. Where the Drawings do not show dimensions for locating equipment, install equipment in the approximate locations indicated on the Drawings.

C. Provide NEC required working space in front of electrical equipment as if it could be worked on energized.

D. Circuits of different service voltage:
   1. Voltage and service levels:
      a. Medium voltage: Greater than 1.0 kV.

b. Low voltage:
    1) Power and controls: 120 V to 480 V.
c. Instrumentation: Less than 50 VDC.

2. Install different service voltage circuits in separate raceways, boxes, manholes, and hand holes.
3. Low voltage and instrumentation circuits may be installed in a common metallic box, wireway, or cable tray with a grounded divider as indicated on the Drawings.

E. Conductors shall not pass through equipment they are not terminating in unless indicated on the Drawings or approved by the Engineer.

3.03 FIELD QUALITY CONTROL

A. Workmanship:
1. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
    a. Neatly coil and label spare wiring lengths.
    b. Shorten, re-terminate, and re-label excessively long used, as well as spare, wire and cable lengths, as directed by the Engineer.

B. Inspection activities conducted during construction do not satisfy the inspection or testing requirements specified in Section 26_08_50 - Field Electrical Acceptance Tests.

C. Provide on-site assistance for troubleshooting and correcting electrical issues discovered during installation and testing for the Project.

3.04 CLEANING

A. General:
1. Clean and vacuum enclosures to remove metal filings, surplus insulation and any visible dirt, dust, or other matter before energization of the equipment or system start-up:
    a. Use of compressors or air blowers for cleaning is not acceptable.
2. Clean luminaries in the areas affected by the construction.

END OF SECTION

SECTION 26_05_02

HAZARDOUS CLASSIFIED AREA CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Executing and completing Work in hazardous and/or classified areas as defined by the NEC, NFPA 820, and as indicated on the Drawings and specified in the Specifications.

1.02 REFERENCES

A. Definitions:
   1. For the purposes of these Specifications, the terms “Hazardous” and “Classified” will be considered synonymous.

B. Standards:
   1. National Electrical Manufacturers Association (NEMA).
   2. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
      b. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   3. Underwriters Laboratories (UL):
      a. 1203 - Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

1.03 QUALITY ASSURANCE

A. Regulatory requirements:
   1. Wiring in hazardous and/or classified locations shall comply with applicable articles of the NEC.
   2. Except as modified in Articles 500 through 516, all other applicable rules contained in the NEC shall apply to electric equipment and wiring installed in hazardous and/or classified locations.
   3. Devices used in Class I, Division 1 or Division 2 areas shall have visible manufacturer installed nameplates specifically stating the Class, Division, and Group for which the device is approved.
   4. PVC-coated fittings for hazardous locations shall be UL 1203 listed after the coating is applied and have a red metal tag attached to the fitting to signify compliance.

1.04 PROJECT OR SITE CONDITIONS

A. The following areas are classified Class I, Division 1, Group D:
   1. Area 440 Sludge Storage Tanks: Interior of tank per NFPA 820-2020, Table 6.2.2(a) Row 11(a).

B. The following areas are classified Class I, Division 2, Group D:
   1. Area 440 Sludge Storage Tanks: area withing 10 feet of walls horizontally and 18 inches above water surface per NFPA 820-2020, Table 6.2.2(a) Row 11(c).
   2. Area 440 Sludge Tank Odor Control System: area within 3 feet of vessels and ducting per NFPA 820-2020, Table 4.2.2, Row 18(d).

1.05 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduit seals shall be filled prior to the introduction of process or gas to the equipment/area.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

A. Conduit installation:
   1. As specified in Section 26_05_33 - Conduits.
   2. Wrench tighten conduit joints to minimize sparking when fault current flows through the conduit system.
   3. Make conduit connections so that there are a minimum of 5 threads fully engaged in the connection.
   4. Flexible conduit:
      a. Class I, Division 1 hazardous areas:
         1) Approved and marked suitable for Class I, Division 1.
         2) Listed for compatibility with the group type atmosphere where used.
      b. Class I, Division 2 areas:
         1) Liquidtight metal conduit with approved fittings.
      c. Maximum length as specified in Section 26_05_33 - Conduits.

B. Sealing fittings:
   1. Provide an approved seal, no more than 12 inches from the enclosure, for conduits entering an enclosure containing switches, circuit breakers, fuses, relays, resistors, or any other apparatus which may produce arcs, sparks, or high temperatures:
      a. Only explosion proof unions, couplings, elbows, capped elbows, and conduit bodies similar to “L”, “T”, and “X” may be installed between the sealing fitting and the enclosure.
   2. Provide entire assemblies approved for Class I locations for self-sealing or factory sealed assemblies where the equipment that may produce arcs, sparks, or high temperatures is located in a compartment separate from the

compartment containing splices or taps, and an integral seal is provided where conductors pass from one compartment to the other:
    a. Seals are required in all conduit connections to the compartment containing splices and must be within 12 inches of the enclosure.
3. Install a conduit seal within 12 inches of the boundary in each conduit run entering or leaving a classified location. No union, coupling, box, or fitting is allowed in the conduit between the sealing fitting and the point at which the conduit leaves the classified location.
4. For underground conduits entering or leaving a classified location or between Class I, Division 1 and Division 2 locations:
    a. Provide a conduit seal at both points where the conduit emerges from the ground:
        1) Place the conduit seal within 18 inches of finished grade.
        2) No union, coupling, box, or fitting is allowed in the conduit system between the seal fitting and the point at which the conduit enters the ground.
5. Separate conductors within the conduit system and seal using an approved packing dam installed to both hold the sealing compound and to maintain the separation between the wires:
    a. Remove the outer jacket of multi-conductor non-shielded cables in the area of the sealing fitting and separate each conductor from the cable and seal individually.
6. Install seals with drains in electrical control stations, low points of conduit, or any place where moisture may condense and accumulate.
7. Install the sealing compound in accordance with the manufacturer's instructions.

C. Boxes and fittings:
1. Class I, Division 1 areas:
    a. Utilize threaded connections for metallic boxes, fittings, and joints to the conduit system.
2. Class I, Division 2 areas:
    a. Provide approved grounding bushings on conduits entering and exiting metallic boxes to bond the conduits together.

D. Outlet boxes and conduit bodies:
1. Suitable for the conduit system as specified in Section 26_05_33 - Conduits.
2. Class I, Division 2 areas:
    a. Boxes not containing arcing parts:
        1) Material and NEMA ratings as specified in Section 26_05_00 - Common Work Results for Electrical.
        2) Pressed metal boxes are not allowed.
    b. Boxes containing arcing parts:
        1) Rated for Class I, Division 1.

E. Motor connections:
1. Conduit installation in Class I, Division 1 and Class I, Division 2 locations for motors that contain arcing parts, shall be as follows:
    a. First - Conduit.
    b. Second - Explosion proof flexible coupling.
    c. Third - Sealing fitting.

d. Fourth - Explosion proof union.
e. Fifth - Connection to the motor terminal box.

2. Wiring connections to motor leads shall be as specified in Section 26_05_21 - Low Voltage Wire Connections.

F. Bond the non-current-carrying metal parts of equipment, raceways and other enclosures as required by the NEC to ensure electrical continuity.

3.02 FIELD QUALITY CONTROL

A. Obtain inspection and approval before and after each seal is poured.

END OF SECTION

SECTION 26_05_09

LOW VOLTAGE MOTORS UP TO 500 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage motors up to 500 horsepower (hp).

1.02 REFERENCES

A. Standards:
   1. American Bearing Manufacturers Association (ABMA):
      a. 9 - Load Ratings and Fatigue Life for Ball Bearings.
      b. 11 - Load Ratings and Fatigue Life for Roller Bearings.
   2. ASTM International (ASTM):
      a. B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
   3. Institute of Electrical and Electronic Engineers (IEEE):
      a. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
      b. 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
      c. 303 - Recommended Practice for Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations.
      d. 841 - IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).
   4. National Electrical Manufacturers Association (NEMA):
      a. MG 1 - Motors and Generators.
   5. Underwriters Laboratories Inc. (UL):
      a. 674 - Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Submit completed motor data sheets for each motor supplied:
   1. As specified in Attachment A - Motor Data Sheet.
   2. Manufacturer’s or other data sheets are not acceptable.

C. Product data:
   1. Descriptive bulletins.
   2. Machine tag and loop number as indicated on the Drawings and in the specification section number of the driven machine.
   3. Complete electrical data.
   4. Manufacturer’s storage recommendations.

5. Torque, current, and power factor versus speed curves:
    a. At 100 percent rated voltage for full voltage started and VFD-driven motors.
    b. For motors on reduced voltage start at 70, 80, 90, and 100 percent rated voltage.
6. Additional data for motors installed in classified areas:
    a. Temperature code.
    b. Hazardous area approval indicating Class, Division, and Group:
        1) For motors driven by variable frequency drives, provide manufacturer's certification that the motor is suitable for operation in the hazardous area when driven by a variable frequency drive.
7. Accessories data:
    a. Power factor correction capacitors:
        1) Size in KVAR for motors not connected to variable frequency drives.
    b. Motor winding heaters:
        1) Voltage.
        2) Watts.
    c. Winding temperature detectors:
        1) Type.
        2) Rating.
    d. Moisture detectors.
8. Mechanical data:
    a. Bearing design and bearing life calculations.
    b. Resonant frequencies for VFD-driven motors 50 hp or greater.

D. Shop Drawings:
1. Motor weight.
2. Frame size.
3. Conduit box(es), size(s), and location(s).
4. Outline drawings with dimensions.
5. Installation details for the project seismic criteria.

E. Calculations:
1. Where Site conditions specified in Section 01_81_50 - Design Criteria exceed manufacturer's ratings, provide derating calculations for each motor.

F. Quality Control Submittals:
1. Manufacturer's representative qualifications.
2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
    a. With test reference standard identified.

G. Certification:
1. When motors are driven by variable speed drive systems, submit certification that selected motor:
    a. Is capable of satisfactory performance under the intended load.
    b. Meets the requirements of the latest edition of NEMA MG 1 Part 31.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store motors in accordance with the manufacturer's recommendations.

1.05 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Furnish and install electric motors and accessories as specified in this Section and the Sections specifying driven equipment to provide a complete and operable installation.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Baldor.
   2. General Electric.
   3. Reliance.
   4. Toshiba.
   5. US Motors.

2.04 EQUIPMENT

A. 3-phase induction motors - general:
   1. Voltage:
      a. Motors 1/2 hp and larger shall be rated 460 V, 3-phase unless otherwise indicated on the Drawings.
      b. Dual voltage motors rated 230/460 V; 3-phase are acceptable provided all leads are brought to the conduit box.
   2. Motors driving identical machines shall be identical.
   3. Motors greater than 1 hp and up to 500 hp shall meet the NEMA Premium Efficiency percent listed in NEMA MG 1.
   4. Horsepower as indicated on the Drawings:
      a. Horsepower ratings indicated on the Drawings are based on vendor's estimates. Provide motors sized for the load of the actual equipment furnished without operating in the service factor.
   5. Service factor:
      a. 1.15 service factor on sine wave power.
      b. 1.0 when driven by VFD.

6. Torque:
    a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
    b. When started using reduced voltage starters:
        1) Provide motors that develop sufficient torque for acceleration to full speed.
    c. NEMA Design B except where driven load characteristics require other than normal starting torque:
        1) In no case shall starting torque or breakdown torque be less than the values specified in NEMA MG 1.
7. Enclosures:
    a. As specified in the individual equipment Specifications or in this Section.
    b. Totally enclosed fan cooled:
        1) Cast iron conduit box.
        2) Tapped drain holes with Type 304 stainless steel plugs for frames 286 and smaller, and automatic breather and drain devices for frames 324 and larger.
    c. Explosion proof:
        1) Tapped drain holes with corrosion resistant plugs for frames 286 and smaller and automatic breather and drain devices for frames 324 and larger.
    d. Lifting devices: Motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
8. Manufactured with cast iron frames in accordance with NEMA MG 1 or manufacturer's standard material for the specified rating.
9. Nameplates:
    a. Provide motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
        1) NEMA standard motor data:
            a) Indicate compliance with NEMA MG 1 Part 31 for inverter duty motors.
        2) AFBMA bearing numbers and lubrication instructions.
10. Hardware:
    a. Type 304 stainless steel.
11. Conduit boxes:
    a. Cast iron or stamped steel.
    b. Split from top to bottom.
    c. Provide gaskets at the following interfaces:
        1) Frames and conduit boxes.
        2) Conduit boxes and box covers.
    d. Rotatable through 360 degrees in 90-degree increments:
        1) Where available based on the size of the conduit box.
    e. Exceeding the dimensions defined in NEMA MG 1.
    f. Provide grounding lugs inside conduit boxes for motor frame grounding.
12. Motor bearings:
    a. Antifriction.
    b. Regreasable and initially filled with grease for horizontal motors and vertical motors in accordance with the manufacturer's standard design.
    c. Bearings and lubrication suitable for ambient temperature and temperature rise.

d. Suitable for intended application and have a rate for ABMA 9 or 11, L-10 rating life of 60,000 hours or more.
e. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.
f. Where specified in the equipment Specifications, provide split-sleeve type hydrodynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.

13. Insulation systems:
    a. Motors installed in ambient temperatures 40 degrees Celsius or less:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 40 degrees Celsius at the altitude where the motor will be installed.
14. Motor leads:
    a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
15. Noise:
    a. Maximum operating noise level in accordance with NEMA MG 1.

B. Submersible motors:
1. Enclosures:
    a. Totally enclosed non-ventilated (TENV) watertight casing.
    b. Inner and outer shaft seals separated by an oil chamber.
2. Cooling:
    a. Suitable for continuous operation in totally, partially, or nonsubmerged condition without overheating.
    b. Convection cooling by the surrounding environment or pump cooling by circulating a portion of the pumped media through a cooling water jacket as recommended by the manufacturer based on hp and application.
3. Electrical cables:
    a. Wire unit without splices. Coordinate with Contractor to ensure cables of adequate length.
    b. Epoxy encapsulated cable entry into terminal box.
4. Insulation:
    a. Sealed moisture resistant windings.
    b. Class H.
5. Motor protection:
    a. Provide temperature detection in motor windings.
    b. Provide moisture detection in motor housing.
    c. Other detection and protection functions specified in the in the driven equipment Section.

C. Vertical motors:
1. Enclosures:
    a. Totally enclosed fan cooled (TEFC) for motors 200 hp and less installed outdoors.
2. Thrust bearings:
    a. Selected for combined rotor and driven equipment loads.
    b. Coordinate with driven equipment supplier for maximum vertical thrust of driven equipment.

D. Motors driven by variable frequency drives:
   1. Compatible with the variable frequency drives specified.
   2. Inverter duty rated and labeled.
   3. Meet the requirements of NEMA MG 1 Part 31.
   4. Winding insulation meets the requirements of NEMA MG 1 Part 31.4.4.2.
   5. Capable of running continuously at 1/10th of full speed, with no harmful effects or overheating.
   6. Shaft grounding ring:
      a. Provide a manufacturer-installed shaft grounding ring for each VFD-driven motor.
      b. Aluminum frame and internal components.
      c. Conductive microfiber brushes.
      d. Maintenance free design.
      e. Colloidal silver compound installed on shaft under the shaft grounding ring.
      f. High frequency ground strap.
      g. Grounding ring:
         1) Installed inside motor housing on drive end (DE).
         2) Installed on exterior of motor housing on drive end with written permission from the Engineer.
      h. Refer to the following table for specific requirements based upon the driven motor:

Motor Size	<100 hp	100 hp to 500 hp	>500 hp
Voltage	<600 VAC	<600 VAC	<600 VAC
AEGIS® Ring	SGR	SGR	PRO
Bearing Insulation	No	NDE	NDE & DE
Colloidal Sliver	Recommended	Required	Required
HF Grounding Straps	Required	Required	Required

Notes:
DE - drive end.
HF - AEGIS® High Frequency Grounding Strap.
NDE - non-drive end.
PRO - AEGIS® PRO Series Shaft Grounding Rings.
SGR - AEGIS® Shaft Grounding Ring Series.

      i. AEGIS® bearing protection ring, as manufactured by Electro Static Technology, or equal.
   7. Explosion proof motors:
      a. On motors less than or equal to 100 hp, provide insulated bearings on one end of the motor.
      b. Shaft grounding ring:
         1) Installed inside the explosion proof enclosure in accordance with IEEE 303.

E. Motors installed in hazardous locations:
   1. Class I, Division 1 or Class II, Division 1 areas:
      a. Enclosures:
         1) Explosion proof for 3-phase motors.
         2) UL listed in accordance with UL 674.
         3) UL approval with nameplate and serial number.

2. Other hazardous areas:
    a. Enclosures:
        1) TEFC for motors in Class I, Division 2 areas.
        2) Vertical motors as specified in this Section.
        3) Hazardous area and temperature code approval stamped on nameplate.

2.05 ACCESSORIES

A. Motor winding heaters:
    1. Provide 3-phase motors with belted or cartridge space heaters mounted within the motor enclosure.
    2. Space heater rating shall be 120 volts, single-phase, unless otherwise indicated on the Drawings.
    3. Power leads for heaters wired into conduit box.
    4. Installed within motor enclosure adjacent to core iron.

B. Winding temperature detectors:
    1. Provide factory installed winding temperature detector with leads terminating in the conduit box:
        a. Where required by the driven equipment Specification or as indicated on the Drawings.
    2. Temperature switches with normally closed contacts as indicated on the Drawings.

2.06 SOURCE QUALITY CONTROL

A. Source Testing:
    1. Motors less than 250 hp:
        a. Perform manufacturer’s standard production tests, including, but not limited to:
            1) No load current.
            2) High potential test.
            3) Winding resistance.
        b. Furnish copies of standard test reports on prototype or identical units.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install motors in accordance with the manufacturer’s instructions.

B. Install shaft grounding ring on VFD-driven motors in accordance with the manufacturer’s instructions.

3.02 FIELD QUALITY CONTROL

A. Field electrical acceptance testing:
   1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

B. Before start-up, perform insulation resistance test on each motor furnished or installed on this project:
   1. Windings energized to 1,000 volts DC for 1 minute.
   2. Resistance measured at the end of the test, recorded, and submitted to the Engineer for review.
   3. Inform the Engineer of any unusual or unacceptable test results.
   4. This test is in addition to the acceptance tests in Section 26_08_50 - Field Electrical Acceptance Tests.

END OF SECTION

ATTACHMENT A - MOTOR DATA SHEET

MOTOR DATA SHEET

MOTOR/ EQUIPMENT TAG _____ MOTOR NUMBER _____

SPECIFICATION NUMBER OF DRIVEN MACHINE _____

MOTOR NAMEPLATE DATA

MANUFACTURER _____ MODEL/SERIES _____ MODEL NO. _____

FRAME _____ ENCLOSURE _____ NEMA DESIGN _____

HP _____ SERVICE FACTOR _____ RPM _____

INSULATION CLASS _____ VOLTS _____ FULL LOAD AMPS _____

AMBIENT TEMP _____ PHASE _____ NO LOAD AMPS _____

DESIGN TEMP _____ HERTZ _____ LOCK ROTOR AMPS _____

INRUSH CODE LETTER _____

	100% LOAD	75% LOAD	50% LOAD
GUARANTEED MINIMUM EFFICIENCIES:			
GUARANTEED MINIMUM POWER FACTOR:			

MAXIMUM SIZE OF POWER FACTOR CORRECTION CAPACITOR: _____ KVAR

ACCESSORIES

MOTOR WINDING HEATER _____ VOLTS _____ WATTS

WINDING THERMAL PROTECTION:

WINDING TEMP SWITCHES (YES/NO) _____

RTD:

TYPE _____ QUANTITY PER PHASE _____ # OF WIRES _____

NOMINAL RESISTANCE _____ NOMINAL TEMP _____ COEFFICIENT _____

RECOMMENDED ALARM _____ DEGREES CELSIUS RECOMMENDED TRIP _____ DEGREES CELSIUS

SPECIAL APPLICATIONS

INVERTER DUTY* (YES/NO) _____ PART WINDING (YES/NO) _____ WYE - DELTA (YES/NO) _____

2 SPEED, 1 WINDING (YES/NO) _____ 2 SPEED, 2 WINDING (YES/NO) _____

AREA CLASSIFICATION:

CLASS _____ DIVISION _____ GROUP _____ TEMP CODE _____

* Conforms to NEMA MG 1 Part 31.

SECTION 26_05_18

600-VOLT OR LESS WIRES AND CABLES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. 600-volt class or less wire and cable.

1.02 REFERENCES

A. Abbreviations:
   1. AWG: American wire gauge.
   2. BCCS: Bare copper-covered steel.
   3. CPE: Chlorinated polyethylene.
   4. FHDPE: Foam high-density polyethylene.
   5. FPE: Foam polyethylene.
   6. OD: Outside diameter.
   7. PVC: Polyvinyl chloride.
   8. XHHW: Cross-linked high heat water resistant insulated wire.

B. Standards:
   1. ASTM International (ASTM):
      a. B3 - Standard Specification for Soft or Annealed Copper Wire.
      b. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. CSA International (CSA).
   3. Insulated Cable Engineers Association (ICEA):
      a. S-90-661 - Individually Unshielded Twisted Pair Indoor Cables for Use in Communication Wiring Systems.
   4. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. NEMA WC 66/ICEA S-116-732 - Standard for Category 6 and 6A, 100 Ohm, Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in LAN Communication Wiring Systems.
      b. NEMA WC 70/ICEA S-95-658-1999 - Standard for Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
   5. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
      b. 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
   6. Telecommunications Industry Association (TIA):
      a. 568.2-D - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
      b. 569-B - Commercial Building Standards for Telecommunications Pathways and Spaces.

7. Underwriters Laboratories Inc. (UL):
    a. 44 - Standard for Thermoset-Insulated Wires and Cables.
    b. 1666 - Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
    c. 2225 - Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
1. Manufacturer of wire and cable.
2. Insulation:
    a. Type.
    b. Voltage class.
3. AWG size.
4. Conductor material.
5. Pulling compounds.

C. Shop Drawings:
1. Show splice locations.
    a. For each proposed splice location provide written justification describing why the splice is necessary.
2. Wire and cable pulling plan:
    a. Provide a pull plan sketch identifying each segment of the pulling calculations, mechanical pulling equipment, and wire/cable spool locations.

D. Test reports:
1. Submit test reports for meg-ohm tests.

E. Calculations:
1. Submit cable pulling calculations to the Engineer for review and comment for cables that will be installed using mechanical pulling equipment. Show that the maximum cable tension and sidewall pressure will not exceed manufacturer recommended values:
    a. Provide a table showing the manufacturer’s recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
    b. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.
    c. Provide the wire and cable pulling plan identified under Shop Drawings with the cable pulling calculations Submittal.

F. Cable lengths:
1. Submit installed cable lengths using a conduit measuring tape for 3-phase circuits.
2. Submit installed lengths of cable for the following single-phase circuits:
    a. Circuits feeding single-phase transformers.
    b. Circuits feeding single-phase panelboards.

1.04 QUALITY ASSURANCE

A. Wires and cables shall be UL listed and labeled.

1.05 PROJECT OR SITE CONDITIONS

A. General Site and Project conditions:
   1. As specified in Section 01_81_50 - Design Criteria.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Color-coding:
   1. Color-coding shall be consistent throughout the facility.
   2. The following color code shall be followed for 240/120-volt and 208/120-volt systems:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Single phase system: Black for 1 hot leg, red for the other.
      e. Neutral: White.
      f. High phase or wild leg: Orange.
      g. Equipment ground: Green.
   3. The following color code shall be followed for 480/277-volt systems:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
      d. Neutral: Gray.
      e. Equipment ground: Green.
   4. The following color code shall be followed for 120 VAC control wiring:
      a. Power: Red.
      b. Neutral: White.
   5. The following color code shall be followed for general purpose DC control circuits:
      a. Grounded conductors: White with blue stripe.
      b. Ungrounded conductors: Blue.
   6. Switch legs shall be violet. 3-way switch runners shall be pink.
   7. Wires in intrinsically safe circuits shall be light blue.
   8. Wire colors shall be implemented in the following methods:
      a. Wires manufactured of the desired color.
      b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:
         1) Colored tape shall be wrapped to overlap half of the width of the tape.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Furnish and install the complete wire and cable system.

2.03 MANUFACTURERS

A. One of the following, or equal:
   1. 600-volt class wire and cable:
      a. Okonite Co.
      b. Prysmian General Cable.
      c. Service Wire.
      d. Southwire Co.
   2. 600-volt VFD cable:
      a. Prysmian General Cable.
      b. Service Wire.
      c. Southwire Co.
   3. Instrumentation class wire and cable:
      a. Alpha Wire Co.
      b. Belden CDT.
      c. Okonite Co.
      d. Prysmian General Cable.
      e. Rockbestos Surprenant Cable Corp.
   4. Network cables:
      a. Belden.
      b. CommScope.
      c. General Cable.

2.04 MATERIALS

A. Conductors:
   1. Copper in accordance with ASTM B3.

2.05 MANUFACTURED UNITS

A. General:
   1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
   2. Permanently mark each wire and cable with the following at 24-inch intervals:
      a. AWG size.
      b. Voltage rating.
      c. Insulation type.
      d. UL symbol.
      e. Month and year of manufacture.
      f. Manufacturer’s name.
   3. Identify and mark wire and cable as specified in Section 26_05_53 - Identification for Electrical Systems:
      a. Use integral color insulation for #2 AWG and smaller wire.
      b. Wrap colored tape around cable larger than #2 AWG.

B. 600-volt class wire and cable:
    1. Provide AWG or kcmil sizes as indicated on the Drawings or in the Conduit Schedules:
        a. When not indicated on the Drawings, size wire as follows:
            1) In accordance with the NEC:
                a) Use 75-degree Celsius ampacity ratings.
                b) Ampacity rating after derating factors, equal to or greater than rating of the overcurrent device.
            2) Provide #12 AWG minimum for power conductors.
            3) Provide #14 AWG minimum for control conductors.
    2. Provide Class B stranding in accordance with ASTM B8:
        a. Provide Class C stranding where extra flexibility is required.
    3. Insulation:
        a. XHHW-2.
        b. 90-degree Celsius rating.

C. 600-volt VFD cables:
    1. Conductor:
        a. Provide Class B stranding in accordance with ASTM B3 and ASTM B8.
        b. Copper conductor.
    2. Insulation:
        a. Cross-linked Polyethylene, XLPE.
        b. 90-degree Celsius rating.
        c. UL 44 type RHH/RHW-2 or XHHW-2.
        d. 2,000 volts.
    3. Ground:
        a. Provide Class B compressed stranded bare copper in accordance with ASTM B3 and ASTM B8.
        b. 3 symmetrically placed bare copper conductors in direct contact with shield.
        c. Equivalent ground size 50 percent of the phase conductor size.
    4. Filler:
        a. Cable sizes 8 and 6 use polypropylene filler.
        b. Other cable sizes use paper filler.
    5. Metallic shield:
        a. Overall 5 mil bare copper tape shield with 50 percent overlap.
    6. Outer jacket:
        a. UL 1277 Type PVC.
    7. Cable tray rated, UL Type TC-ER.

D. Instrumentation class cable:
    1. Type TC.
    2. Suitable for use in wet locations.
    3. Voltage rating: 600 volts.
    4. Temperature rating:
        a. 90-degree Celsius rating in dry locations.
        b. 75-degree Celsius rating in wet locations.
    5. Conductors:
        a. Insulation:
            1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.

b. #16 AWG stranded and tinned.
c. Color code: ICEA Method 1:
1) Pair: Black and white.
2) Triad: Black, white and red.
3) Multiple pairs or triads:
a) Color-coded and numbered.

6. Drain wire:
a. #18 AWG.
b. Stranded, tinned.
7. Jacket:
a. Flame retardant, moisture and sunlight resistant PVC.
b. Ripcord laid longitudinally under jacket to facilitate removal.
8. Shielding:
a. Individual pair/triad:
1) Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
b. Multiple pair or triad shielding:
1) Group shield: Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
2) Completely isolate group shields from each other.
3) Cable shield: 2.35-mil double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
c. Shielding to be in contact with the drain wire.

E. Network cables:
1. Copper Ethernet cable:
a. Provide copper Ethernet cable types as indicated on the Drawings and Specifications.
b. General requirements:
1) Cables shall meet the standards set by TIA-568.2-D and verified by third-party testing laboratory.
2) Conductors:
a) 4 balanced twisted pairs.
(1) #22 to #24 AWG thermoplastic insulated solid copper conducts enclosed by a thermoplastic jacket. Copper clad aluminum is not allowed.
3) Insulation:
a) Non-Plenum: Polyolefin.
b) Plenum: Fluoropolymer.
4) Color coded per T568B.
5) Outer jacket with ripcord.
6) Shielding:
a) Provide F/UTP cables with drain wire for cables inside any equipment or enclosure with 480 VAC and above, outdoor installations, and where indicated on the Drawings.
7) Voltage rating:
a) At a minimum provide 300 VAC rated jacket.
8) Approvals and listings:
a) Meets NEC requirements for each application.
b) Riser applications: Type CMR.

c) Plenum applications: Type CMP.
d) Limited-use applications: Type CMX.

9) Certification:
a) Provide Category 6 cables with NEMA WC 66/ICEA S-116-732 certification.

2.06 ACCESSORIES

A. Wire ties:
1. One of the following, or equal:
a. Panduit, cable ties.
b. T&B, “Ty-Rap” cable ties.

B. Wire markers:
1. As specified in Section 26_05_53 - Identification for Electrical Systems.

2.07 SOURCE QUALITY CONTROL

A. Assembly and testing of cable shall be in accordance with the applicable requirements of NEMA WC 70/ICEA S-95-658-1999.

B. Test type XHHW-2 in accordance with the requirements of UL 44.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install conductors only after the conduit installation is complete, and enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:
1. Install wires only in approved raceways.
2. Do not install wire:
a. In incomplete conduit runs.
b. Until after the concrete work and plastering is completed.

B. Properly coat wires and cables with pulling compound before pulling into conduits:
1. For #4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
a. Ideal Products.
b. Polywater Products.
c. 3M Products.
d. Greenlee Products.
e. Or equal, as recommended by cable manufacturer.
f. Do not use oil, grease, or similar substances.

C. Cable pulling:
1. Prevent mechanical damage to conductors during installation.
2. For cables #1 AWG and smaller, install cables by hand.
3. For cables larger than #1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.

4. Provide documentation that maximum cable pulling tension was no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the Engineer may, at his discretion, require replacement of the cable.
5. Ensure cable pulling crews have calculations and cable pulling limitations while pulling cable.
6. Make splices or add a junction box or pullbox where required to prevent cable pulling tension or sidewall pressure from exceeding 75 percent of the manufacturer's recommendation for the specified cable size:
    a. Make splices in manholes or pull boxes only.
    b. Leave sufficient slack to make proper connections.

D. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within the manufacturer's recommendations.

E. Install and terminate wire in accordance with the manufacturer's recommendations.

F. Neatly arrange and lace conductors in switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:
1. Do not lace wires in gutter or panel channel.
2. Install wire ties with a flush cutting wire tie installation tool:
    a. Use a tool with an adjustable tension setting.
3. Do not leave sharp edges on wire ties.

G. Terminate stranded conductors on equipment box lugs such that conductor strands are confined within the lug:
1. Use ring type lugs if box lugs are not available on the equipment.

H. Lighting circuits:
1. Each circuit shall have a dedicated neutral.

I. Splices:
1. Provide continuous circuits from origin to termination whenever possible:
    a. Obtain the Engineer's approval prior to making any splices.
2. Lighting and receptacle circuit conductors may be spliced without prior approval from the Engineer.
3. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths:
    a. Splice box NEMA rating requirements as specified in Section 26_05_00 - Common Work Results for Electrical.
    b. Make splices in labeled junction boxes for power conductors.
    c. Make splices for control and instrument conductors in terminal boxes:
        1) Provide terminal boards with setscrew pressure connectors, with spade or ring lug connectors.
4. Power and control conductors routed in common raceways may be spliced in common junction boxes.
5. Clearly label junction and terminal boxes containing splices with the words "SPLICE LOCATED WITHIN".
6. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.

7. Install splices with compression type butt splices and insulate using a heat-shrink sleeve:
    a. In NEMA Type 4 or NEMA Type 4X areas, provide heat-shrink sleeves that are listed for submersible applications.
8. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas shall be made waterproof using:
    a. A heat shrink insulating system listed for submersible applications.
    b. Or an epoxy resin splicing kit.

J. Apply wire markers to wires at each end after being installed in the conduit and before meg-ohm testing and termination.

K. Instrumentation class cable:
1. Install instrumentation class cables in separate raceway systems from power cables:
    a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
    b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the Drawings.
3. Shield grounding requirements as specified in Section 26_05_26 - Grounding and Bonding.

L. Copper Ethernet cables:
1. In accordance with TIA-568.2-D.
2. Pathways:
    a. For initial installation, the maximum fill capacity for pathways (i.e., conduit, raceways, trays, baskets) is 40 percent. The maximum fill capacity of 60 percent is allowed to accommodate future additions after initial installation.
    b. Conduit should be run in the most direct route possible with no more than two 90-degree bends between pull boxes and serve no more than 3 outlet boxes.
3. Cable bend radius:
    a. Proper cable bend radius control must be maintained throughout the pathways. Bend radius needs to be at a minimum 10 times the cable diameter.
4. Cable pulling:
    a. Provide cable pulling swivel system to prevent winding and tangling of rope and cables during pull.
    b. Maximum pulling tension is not to exceed the manufacturer’s recommendations. Cable installation should not in any way deform the cable jacket.
    c. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
5. Cable management:
    a. Organize and manage cables for quick and easy moves, adds and changes.

6. Cable termination:
    a. Install equipment outlet connector hardware (e.g., RJ45, M12, etc.), and connect to field equipment outlet (e.g., instrument, VFD, actuator, etc.).
    b. Use shielded connectors as required by the installation.
    c. Coordinate cable termination at copper patch panels with ICSC and General Contractor.
7. Testing:
    a. Copper Ethernet cable testing requirements as specified in Section 26_08_50 - Field Electrical Acceptance Tests.
8. Separation from EMI sources:
    a. In accordance with TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
    b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
        1) Electrical equipment rating less than 2 kVA: A minimum of 5 inches.
        2) Electrical equipment rating between 2 and 5 kVA: A minimum of 12 inches.
        3) Electrical equipment rating more than 5 kVA: A minimum of 24 inches.
    c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
        1) Electrical equipment rating less than 2 kVA: A minimum of 2-1/2 inches.
        2) Electrical equipment rating between 2 and 5 kVA: A minimum of 6 inches.
        3) Electrical equipment rating more than 5 kVA: A minimum of 12 inches.
    d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
        1) Electrical equipment rating less than 2 kVA: No requirement.
        2) Electrical equipment rating between 2 and 5 kVA: A minimum of 3 inches.
        3) Electrical equipment rating more than 5 kVA: A minimum of 6 inches.
    e. Separation between communications cables and electrical motors and transformers, 5 kVA or HP and larger: A minimum of 48 inches.

M. Signal cable:
1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by a minimum of 12 inches.

N. Wiring allowances:
1. Equipment locations may vary slightly from the Drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.
2. Locations for pull boxes, manholes, and duct banks may vary slightly from the Drawings. Include an allowance for necessary conductors and related materials to provide conductors to pull boxes, manholes and duct banks within 20-linear feet of locations indicated on the Drawings.

3.02 FIELD QUALITY CONTROL

A. Field electrical acceptance testing:
   1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

END OF SECTION

SECTION 26_05_21

LOW VOLTAGE WIRE CONNECTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Wire connecting devices.
   2. Terminations.
   3. Splices.
   4. Power distribution blocks.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

B. CSA International (CSA):
   1. C22.2 - No. 197-M1983 (R2208) - PVC Insulating Tape.

C. Underwriters Laboratories, Inc. (UL):
   1. 486A-B - Standard of Safety for Wire Connectors.
   2. 510 - Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
   3. 1953 - Outline of Investigation for Power Distribution Blocks.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Installation instructions.

1.04 QUALITY ASSURANCE

A. Materials shall be UL listed.

1.05 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide a complete system of wiring connectors, terminators, fittings, etc., for a complete wiring system suitable for the cables and conductors used.

2.02 MANUFACTURERS

A. Manufacturers for each type of technology are specified with the equipment in this Section.

2.03 EQUIPMENT

A. Control connections:
   1. Use insulated ring type wire terminators for connections to screw terminals:
      a. With chamfered/funneled terminal barrel entry.
      b. Deep internal serrations.
      c. Long barrel design to reduce electrical resistance and increased insulator-barrel surface area to ensure that the insulator remains in contact with the barrel.
      d. Electroplated-tin copper conductor.
      e. Manufacturers: The following or equal:
         1) ABB, Sta-Kon.
   2. For process equipment connections, work from the manufacturer's drawings.

B. Joints, splices, taps, connections, and terminations:
   1. 600-volt conductors:
      a. Use solderless connectors.
      b. Copper pigtail adaptors.
         1) For use on select applications as approved by the Engineer.
         2) 600 volt, 90 degrees Celsius rated.
         3) UL 486A/B listed.
         4) Manufacturers: One of the following or equal:
            a) Burndy APY series.
            b) ILSCO CPM series.
      c. Use only plated copper alloy connectors or lugs:
         1) Aluminum connectors or lugs are not acceptable for copper conductors.
      d. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.
      e. For wire #10 AWG and smaller, use compression splice caps, with insulating caps:
         1) Manufacturers: The following or equal:
            a) Buchanan, 2006S or 2011S, with 2007 or 2014 insulating caps.
      f. For wire #8 AWG and larger, use heavy duty copper compression connectors:
         1) Manufacturers: One of the following or equal:
            a) ABB.
            b) Burndy.

g. Heat shrink tubing:
1) Suitable for indoors, outdoors, overhead, direct burial or submerged applications.
2) Minimum shrink ratio: 4 to 1.
3) Continuous operating temperature: -55 degrees Celsius to 110 degrees Celsius.
4) Internally applied adhesive sealant.
5) Cross-linked polyolefin:
a) Manufacturers: One of the following or equal:
(1) 3M, ITCSN.
(2) ABB, Shrink-Kon.

2. Instrumentation class cable splices:
a. Suitable for indoor, outdoors, weather exposed, direct buried, or submersed applications.
b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kilovolt.
d. Two-part mold body with tongue and groove seams and built-in spacer webbing.
e. Manufacturers: The following or equal:
1) 3M, Scotchcast 72-N.

C. Insulating tape:
1. General purpose insulating tape:
a. Minimum 7 mil vinyl tape.
b. Suitable for application in an ambient of -18 degrees Celsius (0 degrees Fahrenheit).
c. Operating range up to 105 degrees Celsius (220 degrees Fahrenheit).
d. Flame retardant, hot- and cold-weather resistant, UV resistant.
e. For use as a primary insulation for wire cable splices up to 600 VAC.
f. Meeting and complying with:
1) ASTM D3005, Type I.
2) UL 510.
3) CSA C22.2.
g. Manufacturers: The following or equal:
1) 3M, Scotch Number Super 33+.
2. General purpose color-coding tape:
a. Minimum 7 mil vinyl tape.
b. Suitable for application on PVC and polyethylene jacketed cables.
c. For use indoors and outdoors in weather protected enclosures.
d. Available with the following colors:
1) Red.
2) Yellow.
3) Blue.
4) Brown.
5) Gray.
6) White.
7) Green.
8) Orange.
9) Violet.

e. For use as phase identification, marking, insulating, and harnessing.
f. Meeting and complying with:
    1) UL 510.
    2) CSA C22.2.
g. Manufacturers: The following or equal:
    1) 3M, Scotch Number 35.

D. Power distribution blocks:
1. UL 1953 listed.
2. Short circuit rating: Not less than the system maximum available fault current at the point of application.
3. Provide fuses or circuit breakers in enclosure as required to meet the fault current requirements.
4. Voltage rating: 600 VAC.
5. IP 20 finger safe enclosure.
6. Tin-plated aluminum or copper terminals suitable for copper conductors.
7. Manufacturers: One of the following or equal:
    a. Eaton CHDB series.
    b. Rockwell Automation 1492 PD series.
    c. Schneider Electric LB series.

PART 3 EXECUTION

3.01 INSTALLATION

A. Load connections:
1. Connect loads to the circuits as indicated. Color-code branch circuits as specified in Section 26_05_18 - 600-Volt or Less Wires and Cables.

B. Zero to 600-volt systems:
1. Make connections with the proper tool and die as specified by the device manufacturer.
2. Use only tooling and dies manufactured by the device manufacturer.
3. Insulate connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
4. Number power and control wires before termination.

C. Motor connections (600 volts and below):
1. Terminations on motor leads, including leads that are connected to accommodate the motor current, and the wires entering the motor terminal box from the power source, shall have ring type compression lugs or mechanical torqued insulated lugs.
2. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
    a. In damp and wet locations, use a complete kit containing mastic that shall seal out moisture and contamination.
    b. Shrink cap with low heat as recommended by the manufacturer.

3. Wire markers shall be readable after boot installation.
4. Manufacturers: One of the following or equal:
    a. ABB, Blackburn Insulated multi-taps connectors.
    b. NSI Industries, Polaris insul-tap connectors.
    c. Raychem, MCK.

D. Power distribution terminal blocks:
    1. Connect fuses or circuit breakers on the line side of power distribution terminal blocks as required to meet short circuit requirements.

END OF SECTION

SECTION 26_05_26

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Grounding materials and requirements.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B3 - Standard Specification for Soft or Annealed Copper Wire.
   2. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   3. B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

D. Underwriters Laboratories, Inc. (UL):
   1. 467 - Ground and Bonding Equipment.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.

1.04 QUALITY ASSURANCE

A. Grounding components and materials shall be UL listed and labeled.

1.05 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Ground equipment and raceway systems so that the completed installation is in accordance with applicable code requirements.

B. Provide a complete electrical grounding system as indicated on the Drawings and as specified including but not limited to:
   1. Grounding electrodes.
   2. Bonding jumpers.
   3. Ground connections.

2.02 MANUFACTURERS

A. Compression connectors: One of the following or equal:
   1. ABB.
   2. Burndy.
   3. Erico.
   4. Harger.
   5. Panduit.

B. Ground rods: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Nehring.

C. Ground cable: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Nehring.
   4. Southwire.

D. Precast ground well boxes: One of the following or equal:
   1. Brooks Products, 3-RT Valve Box.
   2. Christy Concrete Products, G12 Valve Box.

2.03 MATERIALS

A. Ground rod:
   1. Minimum: 3/4-inch diameter, 10-feet long.
   2. Uniform 10 mil covering of electrolytic copper metallically bonded to a rigid steel core:
      a. Copper-to-steel bond shall be corrosion resistant.
   3. In accordance with UL 467.
   4. Sectional type joined by threaded copper alloy couplings.
   5. Fit the top of the rod with a threaded coupling and steel-driving stud.

B. Ground cable:
   1. Requirements:
      a. Soft drawn (annealed).

b. Concentric lay, coarse stranded in accordance with ASTM B8.
c. Bare tinned-copper in accordance with ASTM B33.

2. Size is as indicated on the Drawings, but not less than required by the NEC.

C. Compression connectors:
1. Manufactured of high copper alloy specifically for the particular grounding application.
2. Suitable for direct burial in earth and concrete.
3. Identifying compression die number inscription to be impressed on compression fitting.

D. Grounding electrode conductors:
1. Minimum size in accordance with the NEC.

E. Main bonding jumpers and bonding jumpers:
1. Minimum size in accordance with the NEC.

2.04 ACCESSORIES

A. Precast ground well boxes:
1. Minimum 10-inch interior diameter.
2. Traffic-rated cast iron cover.
3. Permanent “GROUND” marking on cover.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide bonding jumpers and wire, grounding bushings, clamps and appurtenances required for complete grounding system to bond equipment and raceways to equipment grounding conductors.

B. Provide a separate grounding conductor for each motor and connect at motor terminal box. Do not use bolts securing motor box to frame or cover for grounding connectors:
1. When grounding motors driven by variable frequency drives (VFD) comply with the requirements of the VFD manufacturer.

C. Provide a grounding type bushing with lug for connection of grounding conductor for conduits that originate from each motor control center section, switchboard, or panelboard:
1. Individually bond these raceways to the ground bus in the equipment.

D. Provide grounding type bushings with lugs for connection of grounding conductor at both ends of metallic conduit runs. Bond ground bushings to the grounding system.

E. Provide a green insulated wire-grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.

F. Interconnect the secondary switchgear, switchboard, or panelboard neutral bus to the ground bus in the secondary switchgear, switchboard, or panelboard compartment, only at service entrance point or after a transformer.

G. Duct bank ground system:
   1. Provide a tinned-copper grounding conductor the entire length of each duct bank, embedded in the concrete of the duct bank as indicated on the Drawings and specified in the Specifications.
   2. Bond duct bank ground conductors together where duct banks join, merge, intersect, or split.

H. Grounding at service (600 V or Less):
   1. Connect the neutral to ground only at one point within the enclosure of the first disconnecting means on the load side of the service transformer.

I. Ground connections:
   1. Connections to the ground grid system, the duct bank grounding system, equipment, ground rods, etc., shall be made using compression type grounding connectors as indicated on the Drawings, UL listed, and labeled for the application.
   2. Make ground connections in accordance with the manufacturer's instructions.
   3. Do not conceal or cover any ground connections until the Engineer or authorized representative has established and provided written confirmation that every grounding connection is as indicated on the Drawings and specified in the Specifications.

J. Grounding electrode system:
   1. Ground ring:
      a. Provide trenching and materials necessary to install the ground ring as indicated on the Drawings.
      b. Ground ring conductor shall be in direct contact with the earth, or where embedded, concrete, of the size as indicated on the Drawings.
      c. Minimum burial depth 36 inches or as indicated on the Drawings.
      d. Re-compact disturbed soils to original density in 6-inch lifts.
   2. Ground rods:
      a. Locations as indicated on the Drawings.
      b. Length of rods forming an individual ground array shall be equal in length.
      c. Drive ground rods and install grounding conductors before construction of concrete slabs and duct banks.
      d. Pre-crimp ground rods, as recommended by the manufacturer, before crimping connector to ground rod.
   3. Metal underground water pipe:
      a. Bond metal underground domestic water pipe to grounding electrode system.
   4. Metal frame of building or structure:
      a. Bond metal frame of building or structure to grounding electrode system.
   5. Extend grounding conductors through concrete to accessible points for grounding equipment and electrical enclosures.

6. Where grounding conductors are exposed and subject to physical damage, install in Schedule 80 PVC conduit for protection.
7. Install grounding system at each structure where switchgear, motor control centers, switchboards, panelboards, panels, or other electrical equipment are installed.

K. Shield grounding:
1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable run.
3. Insulate the shielding and exposed drain wire for each signal cable with heat-shrink tubing.
4. Terminate the signal cable shield on a dedicated grounding terminal block.

L. Where indicated on the Drawings, install ground rods in precast ground wells.

3.02 FIELD QUALITY CONTROL

A. Field electrical acceptance testing:
1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

B. Ground system resistance (electrode to ground) of the completed installation, as determined by tests, shall be:
1. 5 ohms or less for industrial systems.

C. Measure grounding electrode system resistance to ground in accordance with IEEE 81.

3.03 ADJUSTING

A. Under the direction of the Engineer, add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurement meets the specified resistance requirements:
1. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

END OF SECTION

SECTION 26_05_29

HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Mounting and supporting electrical equipment and components.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Anchor: Elements (including hardware) connecting hangers and supports to the structure.
   2. Hardware: Nuts, bolts, straps, clamps, threaded rod, etc.
   3. Supports: Preformed channel or other structural member on which the electrical equipment or raceway is mounted.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Supports:
      a. Materials.
      b. Geometry.
      c. Manufacturer.

2. Hardware:
    a. Materials.
    b. Manufacturer.

C. Shop Drawings:
    1. Dimensioned and scalable Shop Drawings of hangers and supports for distribution systems and equipment.
    2. Complete details for:
        a. Member sizes and arrangement in hangers and support assemblies.
        b. Connections between members in hangers and support assemblies.
        c. Anchoring hangers and supports to structures.
        d. Bracing for hangers and supports and anchoring of bracing to structures.
    3. Include data on connections, attachment hardware and construction to demonstrate that hangers and supports will satisfy the design loading, bracing, and anchoring criteria.

D. Delegated Design Submittals:
    1. Hangers and supports - General:
        a. Locations and conditions:
            1) Hangers and supports inside structures.
            2) Hangers and supports that resist cable pulling/rigging loads.
        b. Required Submittals: Details with supporting calculations for:
            1) Support member arrangement, sizes, and connections.
            2) Bracing to resist cable pulling/rigging loads.
            3) Connections of hangers, supports, and bracing to the structure.
            4) Connections between supports and the equipment or raceway(s) thereon.
    2. Hangers and supports - Exterior and seismic conditions:
        a. Locations and conditions:
            1) Hangers and supports at structures designated as Seismic Design Category (SDC) C, D, E, or F in Section 01_81_50 - Design Criteria.
            2) Hangers and supports for outdoor installations.
        b. Required Submittals:
            1) Interior: Bracing to resist seismic design loads specified in Section 01_81_50 - Design Criteria.
            2) Exterior: Bracing to resist seismic, wind, and other environmental loads specified in Section 01_81_50 - Design Criteria.
    3. Hangers and supports anchored to concrete and masonry:
        a. Locations and conditions:
            1) Post-installed mechanical anchors in tension.
            2) Post-installed adhesive-bonded all-thread rods in tension.
        b. Required Submittals:
            1) Calculations demonstrating that anchors have a demand/capacity ratio (D/C) not greater than the following when anchor capacity is adjusted for moisture conditions, anchor spacing and edge distances, and sustained loading conditions present at the location of installation.
                a) Post-installed mechanical anchors maximum: 85 percent.
                b) Post-installed adhesive-bonded anchors maximum: 75 percent.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Mount raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated supports unless otherwise indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Hangers and supports individually and as a system shall resist weights and code-required forces without deflections and deformations that would damage the supporting elements, the raceway or equipment supported, or the surrounding construction.
   1. Provide the necessary sway bracing to keep support structures from swaying due to lateral forces, including wire and cable pulling forces.
   2. Lateral deflection at top of slab mounted supports shall not exceed support height divided by 240, unless otherwise approved by the Engineer.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Preformed channel:
      a. Eaton B-line.
      b. Power-Strut.
      c. Robroy.
      d. Tyco.
      e. Unistrut.

2.04 MATERIALS

A. Hot dip galvanized steel:
   1. Supports:
      a. In accordance with ASTM A123 or A153.
      b. Minimum zinc coating thickness of 2.5 mils.
      c. Nominal dimensions: 1-5/8 inch by 1-5/8 inch.
   2. Hardware:
      a. Electro-galvanized.
      b. In accordance with ASTM A153.

B. Stainless steel:
    1. Supports:
        a. In accordance with ASTM A240.
        b. ANSI Type 316 material.
        c. Nominal dimensions: 1-5/8 inch by 1-5/8 inch.
    2. Hardware:
        a. ANSI Type 316 material.

2.05 COMPONENTS

A. Fabricated metal supports: As specified in Section 05_50_00 - Metal Fabrications.

2.06 ACCESSORIES

A. Anchors:
    1. As specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.07 FINISHES

A. Paint and finish structures as specified in Section 09_96_01 - High-Performance Coatings.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
    1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
    2. Install anchors of type and material indicated on approved anchoring designs.
    3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Use materials appropriate for the area as specified in Section 26_05_00 - Common Work Results for Electrical.

B. General:
    1. Refer to the Drawings for details. Equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel.
    2. Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.

C. Corrosion protection:
    1. Isolate dissimilar metals, except where required for electrical continuity.
        a. Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.

D. Anchoring methods:
    1. Solid concrete:
        a. Anchor bolts, anchor rods or post-installed anchors as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.
    2. Metal surfaces: Machine screws or bolts.
    3. Hollow masonry units:
        a. Post installed anchors as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.
    4. Wood and metal studs:
        a. When supporting devices on metal or wood stud construction, bridge studs with preformed channel, and mount the devices to the channel.

E. Recoat or seal drilled holes, cut or scratched surfaces or with products recommended by the manufacturer.

F. Group raceway and position on racks to minimize crossovers.

END OF SECTION

SECTION 26_05_33

CONDUITS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Metallic conduits.
   2. Nonmetallic conduits.
   3. Conduit bodies.
   4. Conduit fittings and accessories.
   5. Conduit installation.

1.02 REFERENCES

A. Abbreviations:
   1. GRC: Galvanized rigid steel conduit.
   2. PCA: Polyvinyl chloride (PVC) coated rigid aluminum conduit.
   3. PCS: Polyvinyl chloride (PVC) coated rigid steel conduit.
   4. PVC: Polyvinyl chloride rigid nonmetallic conduit.
   5. SLT: Sealtight-liquidtight flexible conduit.

B. Standards:
   1. American National Standards Institute (ANSI):
      a. C80.1 - Electrical Rigid Steel Conduit.
   2. National Electrical Manufacturers Association (NEMA):
      a. RN-1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Steel Conduit.
   3. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
   4. Underwriters Laboratories (UL), Inc.:
      a. 6 - Standard for Safety Electrical Rigid Metal Conduit - Steel.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Conduit bodies: A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of 2 or more conduit sections. Includes, but not limited to, shapes C, E, LB, T, X, etc.
   2. Conduit fitting: An accessory that primarily serves a mechanical purpose. Includes, but not limited to, bushings, locknuts, hubs, couplings, reducers, etc.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures and Section 26_05_29 - Hangers and Supports.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Furnish complete manufacturer's catalog sheets for every type and size of conduit, fitting, conduit body, and accessories to be used on the Project.
   2. Furnish complete manufacturer's recommended special tools to be used for installation, if required.

C. Delegated Design Submittals:
   1. As specified in Section 26_05_29 - Hangers and Supports.

D. Certifications:
   1. Furnish PVC-coated conduit manufacturer's valid, unexpired certification for each installer.

1.06 QUALITY ASSURANCE

A. Conduits, conduit bodies, and fittings shall be UL listed and labeled.

B. Every installer of PVC-coated metallic conduit shall be certified by the manufacturer for installation of the conduit, and be able to present a valid, unexpired installer certification card prior to installation beginning.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Do not expose non-metallic conduit to direct sunlight.

B. Do not store conduit in direct contact with the ground.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Before performing any trenching locate existing underground utilities:
      a. As specified in Section 33_05_01 - Subsurface Utility Engineering.
         1) Determine underground utility horizontal and vertical location by at least one of the following methods:
            a) Soft excavation.
            b) Local utility location service, CALL BEFORE YOU DIG, or equal.

1.10 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide conduits, conduit bodies, fittings, junction boxes, and necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.

B. Provide location and protection of existing underground utilities, underground conduit trenching, conduit and backfill necessary for the complete installation of underground conduits.

2.02 MANUFACTURERS

A. Galvanized rigid steel conduit:
   1. One of the following or equal:
      a. Allied Tube and Conduit.
      b. Western Tube and Conduit.
      c. Wheatland Tube Co.

B. PVC-coated rigid steel conduit:
   1. One of the following or equal:
      a. Allied.
      b. Calbond.
      c. NEC, Inc. BlackGuard.
      d. Ocal, Inc.
      e. Robroy Ind.

C. PVC-coated aluminum conduit:
   1. One of the following or equal:
      a. Calbond.
      b. NEC, Inc. BlackGuard.
      c. Ocal, Inc.
      d. Robroy Ind.

D. Sealtight-liquidtight flexible conduit:
   1. One of the following or equal:
      a. AFC Cable Systems.
      b. Anaconda.
      c. Electri-Flex Co.
      d. Southwire.

E. Rigid nonmetallic PVC conduit:
   1. One of the following or equal:
      a. Cantex.
      b. Carlon.
      c. Triangle Conduit and Cable.

F. Conduit bodies:
   1. One of the following or equal:
      a. Appleton.

b. Calbond.
c. Carlon.
d. Crouse-Hinds.
e. O-Z/Gedney.
f. Ocal, Inc.
g. Robroy Ind.

G. Joint compound:
1. As recommended by the conduit manufacturer.

H. PVC-coated rigid steel conduit expansion fittings:
1. One of the following or equal:
a. NEC, Inc. BlackGuard.
b. Ocal, Inc.
c. Robroy Ind.

I. Conduit sleeve:
1. One of the following or equal:
a. Appleton.
b. Crouse-Hinds.
c. O-Z/Gedney.

J. Conduit seals:
1. One of the following or equal:
a. Appleton.
b. Crouse-Hinds.
c. O-Z/Gedney.

K. Conduit through wall and floor seals:
1. The following or equal:
a. O-Z/Gedney:
1) Type “WSK.”
2) Type “CSM.”

2.03 COMPONENTS

A. GRC:
1. NPT standard conduit threads with a 3/4-inch taper per foot:
a. Running conduit threads are not acceptable.
2. Hot-dip galvanized inside and out:
a. Ensures complete coverage and heats the zinc and steel to a temperature that ensures the zinc alloys with the steel over the entire surface.
b. Electro-galvanizing is not acceptable.
3. Manufactured in accordance with:
a. UL 6.
b. ANSI C80.1.

B. PCS:
1. Steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material, in accordance with to the requirements for Type GRC.

2. Coated conduit NEMA Standard RN-1:
    a. Galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
3. Factory-bonded PVC jacket:
    a. Exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
    b. Nominal thickness of the exterior PVC coating shall be 0.040 inch, except where part configuration or application of the piece dictates otherwise.
    c. PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.
    d. PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:
        1) Confirm bond with certified test results.
4. Urethane coating shall be uniformly and consistently applied to the interior of conduits and fittings:
    a. Nominal thickness of 0.002 inch.
    b. Conduits having areas with thin or no coating are not acceptable.
    c. Threads shall be coated with urethane.
5. PVC exterior and urethane interior coatings applied to the conduits shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).
6. PCS conduit bodies and fittings:
    a. Malleable iron.
    b. Conduit body, before PVC coating, shall be new, unused material and shall be in accordance with appropriate UL standards.
    c. PVC coating on the outside of conduit bodies shall be 0.040 inch thick and have a series of ribs to protect the coating from tool damage during installation.
    d. 0.002-inch interior urethane coating.
    e. Utilize PVC coating as an integral part of the gasket design.
    f. Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.
    g. PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.
        1) Inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
        2) Sleeve shall provide a vapor- and moisture resistant seal at every connection.
        3) Fittings shall be Form 8 and supplied with plastic encapsulated stainless steel cover screws. Fittings shall be UL Type 4X. Fittings shall be from the same manufacturer as the conduit in order to maintain system continuity and warranty.

C. PCA:
1. Aluminum conduit, before PVC coating, shall be new, unused, aluminum conduit and shall be in accordance with the requirements for Type RAC.

2. Factory-bonded PVC jacket:
    a. Nominal thickness of the exterior PVC coating shall be 0.040 inch, except where part configuration or application of the piece dictates otherwise.
    b. PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.
3. PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:
    a. Confirm bond with certified test results.
4. Urethane coating shall be uniformly and consistently applied to the interior of conduits and fittings:
    a. Nominal thickness of 0.002 inch.
    b. Conduits having areas with thin or no coating are not acceptable.
    c. Threads shall be coated with urethane.
5. PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).
6. PCA conduit bodies and fittings:
    a. Copper-free cast aluminum.
    b. Conduit body, before PVC coating, shall be new, unused material and shall be in accordance with appropriate UL standards.
    c. PVC coating on the outside of conduit bodies shall be 0.040 inch thick and have a series of longitudinal ribs to protect the coating from tool damage during installation.
    d. 0.002-inch interior urethane coating.
    e. Utilize PVC coating as an integral part of the gasket design.
    f. Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.
    g. PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.
        1) Inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
        2) Sleeve shall provide a vapor- and moisture tight seal at every connection.

D. SLT:
1. Temperature rated for use in the ambient temperature at the installed location but not less than the following:
    a. General purpose:
        1) Temperature range: -20 degrees Celsius to +80 degrees Celsius.
    b. Oil-resistant:
        1) Temperature range: -20 degrees Celsius to +60 degrees Celsius.
2. Sunlight-resistant, weatherproof, and watertight.
3. Manufactured from single strip steel, hot-dip galvanized on all 4 sides before conduit fabrication.
4. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
5. Overall PVC jacket.
6. With integral copper ground wire, built in the core, in conduit trade sizes 1/2 inch through 1-1/4 inch.

E. PVC:
   1. Extruded from virgin PVC compound:
      a. Schedule 40 unless otherwise specified.
      b. Schedule 80 extra-heavy wall where specified.
   2. Rated for 90 degrees Celsius conductors or cable.
   3. Rated for use in direct sunlight.

F. Conduit bodies:
   1. Material consistent with conduit type:
      a. [Malleable iron bodies and covers when used with Type GRC.
      b. PVC bodies and covers when used with Type PVC.
      c. PVC-coated malleable iron bodies and covers when used with Type PCS.
      d. PVC-coated copper-free cast aluminum bodies and covers when used with Type PCA.
   2. Conduit bodies to be in accordance with to Form 8, Mark 9, or Mogul design:
      a. Mogul design in accordance with to NEC requirements for bending space for large conductors for conduit trade sizes of 1 inch and larger with conductors #4 AWG and larger, or where required for wire-bending space.
   3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.

2.04 ACCESSORIES

A. Connectors and fittings:
   1. Manufactured with compatible materials to the corresponding conduit.

B. Insulated throat metallic bushings:
   1. Construction:
      a. Malleable iron or zinc-plated steel when used with steel conduit.
      b. Positive metallic conduit end stop.
      c. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
      d. Use fully insulated bushings on nonmetallic conduit system made of high-impact 150 degrees Celsius rated non-combustible thermosetting phenolic.

C. Insulated grounding bushings:
   1. Construction:
      a. Malleable iron or steel, zinc-plated, with a positive metallic end stop.
      b. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
      c. Tin-plated copper grounding saddle for use with copper or aluminum conductors.

D. Electrical unions (Erickson Couplings):
   1. Construction:
      a. Malleable iron for use with steel conduit.
      b. PVC-coated malleable iron for use with PCS conduit.
      c. PVC-coated copper-free cast aluminum for use with PCA conduit.
      d. Concrete tight, 3-piece construction.
      e. Rated for Class I, Division 1, Group D in hazardous areas.

E. SLT fittings:
   1. Construction:
      a. Malleable iron.
      b. Furnished with locknut and sealing ring.
      c. Liquidtight, raintight, oiltight.
      d. Insulated throat.
      e. Furnish as straight, 45-degree elbows, and 90-degree elbows.
      f. Designed to prevent sleeving:
         1) Verify complete bonding of the raceway jacket to the plastic gasket seal.
      g. Equipped with grounding device to provide ground continuity irrespective of raceway core construction. Grounding device, if inserted into raceway and directly in contact with conductors, shall have rolled-over edges for sizes under 5 inches.
      h. Where terminated into a threadless opening using a threaded hub fitting, a suitable moisture-resistant/oil-resistant synthetic rubber gasket shall be provided between the outside of the box or enclosure and the fitting shoulder. Gasket shall be adequately protected by and permanently bonded to a metallic retainer.
   2. Corrosion-resistant and outdoor SLT fittings:
      a. Construction:
         1) PVC-coated liquidtight fittings with a bonded 0.040-inch thick PVC coating on the metal connector to form a seal around the SLT conduit.
         2) Insulated throat and an integral sealing ring.

F. Hubs for threaded attachment of steel conduit to sheet metal enclosures:
   1. Construction:
      a. Insulated throat.
      b. PVC-coated when used in corrosive areas.
      c. Bonding locknut.
      d. Recessed neoprene O-ring to ensure watertight and dusttight connector.
      e. 1/2-inch through 1-1/4-inch steel zinc electroplated.
      f. 1-1/2-inch through 6-inch malleable iron zinc plated.
   2. Usage:
      a. Conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.

G. Sealing fittings:
   1. Construction:
      a. 40-percent wire fill capacity.
      b. PVC-coated when used in corrosive areas.
      c. PVC Coated Hazardous (Classified) Location fittings must be UL 1203 listed after the coating is applied and have a red metal tag attached to the fitting to signify compliance.]
      d. Malleable ductile iron with steel conduit.
      e. Aluminum with aluminum conduit.
      f. Type EYDX where drains are required.
      g. Type EYSX where drains are not required.
      h. UL 1203 listed for use in Class I, Division 1, Groups A, B, C, D; Class I, Division 2, Groups A, B, C, D; and Class II, Divisions 1 and 2, Groups E, F, and G.

2. Sealing compound:
    a. Fiber filler and cement as recommended by the sealing fitting manufacturer.
    b. Approved for the conditions and use.
        1) Not affected by surrounding atmosphere or liquids.
    c. Melting point shall be 200 degrees Fahrenheit minimum.

H. PVC fittings:
1. Materials:
    a. Devices shall be made of PVC, using the same materials as used for Type PVC conduit.
    b. Metal hardware shall be stainless steel.

I. Through wall and floor seals:
1. Materials:
    a. Body: Casting of malleable or ductile iron with a hot-dip galvanized finish.
    b. Grommet: Neoprene.
    c. Pressure rings: PVC-coated steel.
    d. Disc material: PVC-coated steel.

J. Expansion/deflection couplings:
1. Use to compensate for movement in any directions between 2 conduit ends where they connect.
2. Shall allow movement of 3/4 inch from the normal in all directions.
3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
4. Constructed to maintain electrical continuity of the conduit system.
5. Materials:
    a. End couplings: Bronze or galvanized ductile iron.
    b. Sleeve: Neoprene.
    c. Bands: Stainless steel.
    d. Bonding jumper: Tinned copper braid.

K. Expansion couplings:
1. Shall allow for expansion and contraction of conduit:
    a. Permitting 8-inch movement, 4 inches in either direction.
2. Constructed to maintain electrical continuity of the conduit system.
3. Materials:
    a. Head: Malleable or ductile iron.
    b. Sleeve: Steel.
    c. Insulating bushing: Phenolic.
    d. Finish: Hot-dip galvanized.
    e. PVC-coated steel when used with Type PCS.

L. Conduit markers:
1. As specified in Section 26_05_53 - Identification for Electrical Systems.

PART 3 EXECUTION

3.01 EXAMINATION

A. Before installing any conduit or locating any device box:
   1. Examine the complete set of Drawings and Specifications, and applicable Shop Drawings.

B. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

3.02 INSTALLATION

A. General:
   1. Conduit routing:
      a. Electrical drawings are diagrammatic in nature:
         1) Install conduit runs as specified with schematic representation indicated on the Drawings and as specified.
         2) Modify conduit runs to suit field conditions, as accepted by the Engineer:
            a) Make changes in conduit locations that are consistent with the design intent but are dimensionally different, or routing to bypass obstructions.
            b) Make changes in conduit routing due to the relocation of equipment.
            c) Install conduits and equipment in such a manner as to avoid obstructions and to preserve headroom and keep openings and passageways clear.
         3) Where the Drawings do not indicate the exact mounting and/or supporting method to be used, use materials and methods similar to the mounting details indicated on the Drawings.
         4) Electrical drawings do not indicate all required junction boxes and pull boxes:
            a) Provide junction boxes and pull boxes to facilitate wire pulling as required:
               (1) To meet cable manufacturer’s pulling tension requirements.
               (2) To limit total conduit bends between pull locations.
            b) Install junction boxes and pull boxes at locations acceptable to the Engineer.
      b. Contractor is responsible for any deviations in general location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer:
         1) Engineer is the sole source in determining whether the change is constituted as a deviation.
         2) Perform any changes resulting in additional conduits, or extra work from such deviations.
         3) Incorporate any deviations on the Record Documents.
   2. Use only tools recommended by the conduit manufacturer for assembling the conduit system.

3. Provide adequate clearances from high-temperature surfaces for conduit runs. Provide minimum clearances as follows:
    a. Clearance of 6 inches from surfaces 113 degrees Fahrenheit to 149 degrees Fahrenheit.
    b. Clearance of 12 inches from surfaces greater than 149 degrees Fahrenheit.
    c. Keep conduits at least 6 inches from the coverings on hot water and steam pipes, 18 inches from the coverings on flues and breechings, and 12 inches from fuel lines and gas lines.
    d. Where it is necessary to route conduits close to high-temperature surfaces, provide a high-reflectance thermal barrier between the conduit and the surface.
4. Support conduit runs on water-bearing walls a minimum of 7/8 inch away from the wall on an accepted preformed channel:
    a. Do not run conduits within water-bearing walls unless otherwise indicated on the Drawings.
5. Do not install 1-inch or larger conduits in or through structural members unless approved by the Engineer.
6. Run conduits exposed to view parallel with or at right angles to structural members, walls, or lines of the building:
    a. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends.
    b. Make changes in direction with long radius bends or with conduit bodies.
7. Install conduits with total conduit bends between pull locations less than or equal to 270 degrees.
8. Route exposed conduits to preserve headroom, access space and workspace, and to prevent tripping hazards and clearance problems:
    a. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and do not block or interfere with ingress or egress, including equipment-removal hatches.
    b. Route conduits to avoid drains or other gravity lines. Where conflicts occur, relocate the conduit as required.
9. When installing conduits through existing slabs or walls, make provisions for locating any possible conflicting items where the conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into the existing conduits, piping, cables, post-tensioning cables, etc.
10. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
11. Install conduits through wall and floor seals where indicated on the Drawings.
12. For new and existing underground and embedded conduits 1 inch and larger, snake conduits with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of the conduit.
13. Provide sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically indicated on the Drawings.
14. Install complete conduit systems before conductors are installed.
15. Provide metallic conduits terminating in transformer, switchgear, motor control center, or other equipment conduit windows with grounding bushings and ground with a minimum No. 6 AWG ground wire.

16. Underground conduits:
    a. Install underground conduits, including conduit runs below slabs-on-grade in concrete-reinforced duct bank construction:
        1) As specified in Section 26_05_44 - Duct Banks.
    b. Make underground conduit size transitions at handholes and manholes.
    c. Install spare conduits in underground duct banks towards top center of runs to allow for ease of installation of future cables as conduits enter underground manholes and handholes.
    d. Seal around conduit penetrations of below grade walls with a mechanical seal.
17. Underground conduit trenching:
    a. Perform trenching as specified in Section 31_23_35 - Trenching.
    b. Trench must be uniformly graded with the bottom, rock free and covered with select material.
    c. Damage occurring to existing ducts, conduits, cables, and other utilities during underground conduit installation shall be remediated to the satisfaction of the Owner.
    d. Whenever possible, use the walls of the trench as forms for concrete encasement:
        1) Forms are required where the soil is not self-supporting.

B. Equipment grounding conductors:
    1. Provide a separate, green insulated, grounding conductor in each raceway independent of raceway material:
        a. Multi-conductor power and control cables shall include an integral green insulated grounding conductor.
        b. Provide a separate grounding conductor in each individual raceway for parallel feeders.
    2. Conductors shall be the same type and insulation as the circuit conductors:
        a. Use 600-volt insulation for the equipment grounding conductors for medium voltage systems.
    3. Minimum size in accordance with the NEC.

C. Lighting and receptacle conduits:
    1. Provide conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings.
    2. Install conduits in accordance with the requirements of this Section unless otherwise indicated.
    3. Minimum conduit size:
        a. 3/4 inch for exposed conduits.
    4. Provide conduit materials for the installed location as specified in Section 26_05_00 - Common Work Results for Electrical.

D. Hazardous areas:
    1. As specified in Section 26_05_02 - Hazardous Classified Area Construction for hazardous areas and specific Class and Division.

E. Conduit usage:
1. Exposed conduits:
a. Rigid conduit:
1) Install the rigid conduit type for each location as specified in Section 26_05_00 - Common Work Results for Electrical.
2) Minimum size: 3/4 inch.
b. Flexible conduit:
1) Use flexible conduit for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment, or where required for equipment servicing:
a) Use Type SLT with rigid metallic conduit.
2) Minimum size: 3/4 inch:
a) 1/2 when required for connection to instruments.
3) Maximum length:
a) Fixed equipment:

Conduit Trade Size	Flexible Conduit Length (inch)
3/4	18
1	18
1-1/4	18
1-1/2	18
2	36
2-1/2	36
3	36
3-1/2	38
4	40

b) Removable instruments or hinged equipment:
(1) As required to allow complete removal or full movement without disconnecting or stressing the conduit.

2. Concrete-encased and embedded conduits:
a. Straight runs and bends less than 45 degrees:
1) Type PVC Schedule 40.
b. Bends with total deflection greater than 45 degrees;
1) PCS.
c. Entering and exiting duct bank, underground or embedded conduit runs a minimum 12 inches above and below grade, finished floor, or entering equipment:
1) PCS.
d. Minimum size:
1) 2 inch in duct banks.
2) 1 inch for in-slab conduits.
3) Provide conduit fittings to enlarge the conduit from the exposed size in the conduit schedule as required.
3. Direct-buried and sand-bedded duct bank conduits:
a. Type PCS.
b. Minimum size: 1 inch.

4. PVC-coated rigid metallic conduit:
    a. Use specifically manufactured or machined threading dies to manufacturer's specifications to accommodate the PVC jacket.
    b. Repair damage to PVC coatings with manufacturer supplied touchup compound or PVC Coating Repair Kit for PVC Coated Raceway Systems.
5. GRC:
    a. Conduit shall be cut square and reamed before threading.

F. Conduit joints and bends:
1. General:
    a. Where conduit is underground, under slabs on grade, exposed to the weather, or in NEMA Type 4 or NEMA Type 4X locations, make joints liquidtight.
    b. Keep bends and offsets in conduit runs to an absolute minimum.
    c. Bends shall be symmetrical.
    d. Provide factory-made elbows for large-radius bends for conduits 1-1/4-inch trade size or larger.
    e. Make field bends with a radius of not less than the requirements found in the NEC:
        1) Minimum bending radius of the cable must be less than the radius of the conduit bend.
        2) Make field bends with power bending equipment or manual benders specifically intended for the purpose:
            a) Make bends so that the conduit is not damaged and the internal diameter is not effectively reduced.
            b) For the serving utilities, make bends to meet their requirements.
        3) For PCS conduit, field bends are permitted on conduits 1 inch and smaller. Manufactured elbows shall be used on conduits larger than 1 inch.
    f. Replace deformed, flattened, or kinked conduit.
2. Threaded conduit:
    a. Cut threads on rigid metallic conduit with a standard conduit-cutting die that provides a 3/4-inch per foot taper and to a length such that bare metal exposed by the threading operation is completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that joints become secure and wrench-tight just preceding the point where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.
    b. Thoroughly ream conduit after threads have been cut to remove burrs.
    c. Use bushings or conduit fittings at conduit terminations.
    d. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing Galvabar™, or CRC Zinc It.
    e. Coat conduit threads with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation:
        1) Apply to the male threads and tighten joints securely.
        2) Clean excess sealant from exposed threads after assembly.
    f. Securely tighten threaded connections.
    g. Any exposed threaded surfaces must be cleaned and coated with a galvanizing solution so that exposed surfaces have a galvanized protective coating.

3. PVC:
    a. Use approved solvent-weld cement specifically manufactured for the purpose. Spray-type cement is not allowed.
    b. Apply heat for bends so that conduit does not distort or discolor. Use a spring mandrel as required to ensure full inside diameter at bends:
        1) Utilize a heater specifically for PVC conduit as recommended by the conduit manufacturer.

G. Conduit sealing and drainage:
1. Other than required for hazardous and classified areas:
    a. Provide sealing and drainage in vertical drops of long (in excess of 20 feet), exterior, above-grade conduit runs at the points at which the conduit enters buildings, switchgear, control panels, lighting panelboards, and other similar enclosures.
    b. Provide seal fittings with drains in vertical drops directly above grade for exterior and above-grade conduit runs that are extended below grade.
    c. Provide conduit seals with drains in areas of high humidity and rapidly changing temperatures:
        1) Where portions of an interior raceway pass through walls, ceilings, or floors that separate adjacent areas having widely different temperatures.
    d. Provide conduit seals similar to O-Z/Gedney (Type CSM) on conduits between corrosive and non-corrosive areas.
    e. Seal one end only of underground conduits at highest point with O-Z/Gedney sealing (non-hazardous) filling, or equal.
2. Install seals with drains at any location along conduit runs where moisture may condense or accumulate. This requirement includes, but is not limited to, the following locations: Control panels, junction boxes, pullboxes, or low points of the conduit.

H. Hangers and supports:
1. General:
    a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
        1) As specified in Section 26_05_29 - Hangers and Supports.
        2) Provide support materials consistent with the type of conduit being installed as specified in Section 26_05_00 - Common Work Results for Electrical.
    b. Support conduit at the intervals required by the NEC.
    c. Perforated strap and plumbers' tape are not acceptable for conduit supports.
2. Conduit on concrete or masonry:
    a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
    b. Use preset inserts in concrete when possible.
    c. Use pipe spacers (clamp backs) in wet locations.
3. Suspended conduit:
    a. Use malleable-iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.
    b. For grouped conduits, construct racks with threaded rods and tiered angle iron or preformed channel cross members. Clamp each conduit

individually to a cross member. Where rods are more than 2 feet long, provide rigid sway bracing.

4. Supports at structural steel members:
    a. Use beam clamps.
    b. Drilling or welding may be used only as specified or with approval of the Engineer.
5. PVC-coated rigid metal systems:
    a. Provide right-angle beam clamps and “U” bolts specially formed and sized to snugly fit the outside diameter of the coated conduit. Provide “U” bolts with PVC-encapsulated nuts that cover the exposed portions of the threads.
    b. Securely fasten exposed conduits with Type 316 stainless steel clamps or straps.

I. Expansion or expansion/deflection fittings:
1. General:
    a. Align expansion coupling with the conduit run to prevent binding.
    b. Follow manufacturer’s instructions to set the piston opening.
    c. Install expansion fittings across concrete expansion joints and at other locations where necessary to compensate for thermal or mechanical expansion and contraction.
    d. Furnish fittings of the same material as the conduit system.
2. For metallic conduit, provide expansion or expansion/deflection couplings, as appropriate, where:
    a. Install expansion fittings a minimum of every 200 feet in straight conduit runs.

J. Empty conduits:
1. Provide a pull tape in each empty conduit more than 10 feet in length.
2. Seal ends of conduits with approved, manufactured conduit seals, caps, or plugs immediately after installation:
    a. Keep ends sealed until immediately before pulling conductors.

K. Miscellaneous:
1. Provide electrical unions at all points of union between ends of rigid conduit systems that cannot otherwise be coupled:
    a. Running threads and threadless couplings are not allowed.
2. Replace any conduits installed that the Engineer determines do not meet the requirements of this Specification.
3. Provide conduit housekeeping curb around embedded or below-grade conduits exiting or entering the slab, in accordance with the Typical Details.

END OF SECTION

SECTION 26_05_34

BOXES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Device boxes.
   2. Raceway system boxes.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Castings.

C. Joint Industry Conference (JIC).

D. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

E. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

F. Underwriters Laboratories, Inc. (UL).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Arcing parts: Circuit breakers, motor controllers, switches, fuses, or any device intended to interrupt current during its operation.
   2. Raceway system boxes: Boxes that are used for wire and cable pullboxes, conduit junction boxes, or terminal boxes.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Manufacturer.
   2. Materials.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.

d. Weight.
e. NEMA rating.
4. Conduit entry locations.
5. Catalog cutsheets.
6. Installation instructions.

C. Shop Drawings:
1. Include identification and sizes of pullboxes.

1.05 QUALITY ASSURANCE

A. Regulatory requirements:
1. Device boxes shall comply with the applicable standards of:
a. JIC.
b. NEC.
c. NEMA.
d. UL.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide device boxes for wiring devices, junction, and pullboxes for use in the raceway systems, etc.

B. Provide boxes as indicated on the Drawings and as needed to complete the raceway installation.

C. Size pullboxes in accordance with NEC requirements and to provide sufficient room for any future conduits, components, and cables as indicated on the Drawings.

D. Provide materials and construction suitable for environmental conditions at the location of the box as specified in Section 26_05_00 - Common Work Results for Electrical.

E. For boxes not indicated:
1. Provide device boxes to match the exposed conduit system. Provide junction boxes and pull boxes as specified in Section 26_05_00 - Common Work Results for Electrical.

2.02 MANUFACTURERS

A. One of the following or equal:
   1. Plastic coated boxes:
      a. OCAL.
      b. Rob Roy.
   2. Cast device boxes:
      a. Appleton.
      b. Crouse - Hinds.
      c. O-Z/Gedney.
   3. Explosionproof enclosures:
      a. Adalet.
      b. Crouse-Hinds.
      c. O-Z/Gedney.
   4. Formed steel enclosures:
      a. Hoffman.
      b. Rittal
      c. Stahlin.
   5. Stainless steel enclosures:
      a. Hoffman.
      b. Rittal.
      c. Stahlin.

2.03 MANUFACTURED UNITS

A. Cast device boxes:
   1. Construction:
      a. FD type.
      b. With internal green ground screw.
      c. Furnished with a suitable gasketed cover.
      d. With integral cast mounting lugs when surface mounted.
      e. Conduit sizes range from 3/4 inch to 1 inch.
      f. Tapered threaded hubs with integral bushing.
   2. Aluminum (copper free) boxes:
      a. High strength copper free 4/10 of 1 percent maximum alloy for use with aluminum rigid conduit.
   3. Malleable iron boxes:
      a. In accordance with ASTM A47 Grade 32510.

B. Plastic coated cast device boxes:
   1. Construction:
      a. FD type.
      b. With internal green ground screw.
      c. Furnished with a suitable gasketed cover.
      d. With integral cast mounting lugs when surface mounted.
      e. Conduit sizes range from 3/4 inch to 1 inch.
      f. Double coated with a nominal 0.002-inch (2 mil) urethane on both the interior and exterior before application of PVC coating.
      g. With a minimum 0.040-inch (40 mil) PVC coating bonded to exterior.
      h. With pressure sealing sleeve to protect the connection with conduit.

C. Explosionproof enclosures:
   1. Dual rated NEMA Type 7 and NEMA Type 4X.
   2. Cast copper free aluminum box and cover.
   3. Precision machined flame path between box and cover with O-ring.
   4. Cast-in-place or bolt-on stainless steel slotted mounting feet for horizontal or vertical mounting.
   5. For applications requiring hinged cover, provide flexible hinge mounting either left or right side.
   6. External flange.
   7. Provisions for mounting pan.
   8. Stainless steel cover bolts and hardware.
   9. Ground lug.

D. Formed steel enclosures:
   1. Steel:
      a. NEMA Type 12.
      b. Fabricated from 14-gauge steel, minimum.
      c. Seams continuously welded ground smooth.
      d. Door:
         1) Rolled lip around 3 sides.
         2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
      e. Neoprene door gasket to provide a watertight, dusttight, oiltight seal:
         1) Attached with an adhesive.
         2) Retained by a retaining strip.
      f. Fabricate external removable hardware for clamping the door to the enclosure body from zinc-plated heavy gauge steel:
         1) With a hasp and staple for padlocking.
      g. Provide large enclosures with door and body stiffeners for extra rigidity.
      h. No holes or knockouts.
      i. Finish:
         1) ANSI 61 gray electrostatically applied polyester powder inside and out over cleaned and primed surfaces.
         2) White electrostatically applied polyester powder mounting plate.
      j. Heavy gauge steel external mounting brackets when surface mounted.
   2. Stainless steel:
      a. NEMA Type 4X.
      b. Fabricated from 14-gauge Type 316 stainless steel.
      c. Seams continuously welded.
      d. Door:
         1) Rolled lip around 3 sides.
         2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
      e. Neoprene door gasket to provide a watertight seal:
         1) Attached with an adhesive.
         2) Retained by a retaining strip.
      f. Fabricate external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel:
         1) With a hasp and staple for padlocking.
      g. Provide large enclosures with door and body stiffeners for extra rigidity.
      h. No holes or knockouts.

i. Finish:
1) Brushed.
j. Stainless steel external mounting brackets when surface mounted.

E. Cast iron junction boxes:
1. NEMA Type 4.
2. Recessed cover boxes.
3. Suitable for use outdoors where subject to rain, dripping, or splashing water.
4. Designed for flush mounting in walls or floors:
a. Can be surface mounted using mounting lugs.
5. Construction:
a. Cast iron.
b. Covers:
1) Checkered plate covers suitable for foot traffic.
2) When used in areas subject to vehicular traffic, design to support an AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading.
c. Hot dip galvanized.
d. Neoprene gasket.
e. Stainless steel screw covers.

2.04 ACCESSORIES

A. Fasteners:
1. Electroplated or stainless steel in boxes with wiring devices.
2. Screws, nuts, bolts, and other threaded fasteners:
a. Stainless steel.

B. Provide breather and drain fittings where appropriate.

C. Internal panels:
1. Provide internal panels where required for mounting of terminal strips or other equipment.
2. With plated steel shoulder studs.
3. Steel with white polyester powder finish.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Support wall mounted NEMA Type 4 or NEMA Type 4X boxes to maintain a minimum of 7/8-inch free air space between the back of the enclosure and the wall:
a. Use machined spacers to maintain air space; built-up washers are not acceptable.
b. Use stainless steel or nylon materials for spacers.
2. Use cast boxes when the box will support other devices.

3. Boxes serving luminaires or wiring devices:
    a. Use as pullboxes wherever possible.
4. For fire-rated construction, provide materials and installation for use in accordance with the listing requirements of the classified construction.

B. Device boxes:
1. Locate device boxes as indicated on the Drawings:
    a. Adjust locations so as not to conflict with structural requirements or other trades.
2. Provide outlet box materials to match the exposed conduit system:
    a. GRC - Cast ferrous boxes.
    b. PCS - PVC coated cast ferrous boxes.
    c. PCA - PVC coated aluminum boxes.
3. Use cast boxes:
    a. Where subject to mechanical damage:
        1) Defined as exposed boxes less than 10 feet above the floor in unfinished rooms.
    b. To act as a pullbox for conductors in a conduit system.
4. Device and junction boxes for flush mounting in clean, dry locations:
    a. One-piece, galvanized, pressed steel.
5. Device boxes may be used as junction boxes wherever possible.

C. Pullboxes and junction boxes:
1. Provide junction box materials and NEMA ratings as specified in Section 26_05_00 - Common Work Results for Electrical.
2. Install pullboxes such that access to them is not restricted.
3. Fire rated construction: Use materials and methods to comply with the listing requirements for the classified construction.

D. Hazardous locations:
1. Class I, Division 1 areas:
    a. Provide boxes designed and listed for Class I, Division 1 locations and group type atmosphere in which they will be used:
        1) Approval ratings must be permanently marked on each item.
2. Class I, Division 2 areas:
    a. For boxes not containing arcing parts:
        1) As specified in Section 26_05_00 - Common Work Results for Electrical.
        2) Pressed metal boxes are not allowed.
    b. For boxes containing arching parts provide:
        1) Boxes designed and listed for Class I, Division 1 locations and group type atmosphere in which they will be used:
            a) Approval ratings must be permanently marked on each item.
3. Metallic boxes, fittings, and joints shall utilize threaded connections to the conduit system.
4. Threaded connections shall be wrench tightened so that at least 5 threads are fully engaged.
5. Conduits entering and exiting metallic boxes in Class I, Division 2 areas shall utilize approved grounding bushings to bond the conduits together.

END OF SECTION

SECTION 26_05_44

DUCT BANKS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Electrical underground duct banks.
   2. Duct bank installation requirements.

1.02 REFERENCES

A. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. PVC conduit spacers.
   2. Detectable underground marking tape.
   3. Pull line.
   4. Duct seal.

C. Shop Drawings:
   1. Submit Site plan drawings of duct banks, including underground profiles indicating underground utilities.
   2. Submit cross section of each duct bank with dimensions.
   3. For duct bank routings crossing under building footers or foundations alternative to designed routings indicated on the Drawings:
      a. Submit Shop Drawings detailing the new building footer crossing locations and plan drawings labeling equipment to be installed on top of the new routing for approval by the Project structural engineer.

1.04 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

B. Field conditions and related requirements:
   1. Underground water table may be near or above the location of new duct banks.
   2. Include cost for necessary dewatering, and cleaning equipment to perform Work in underground duct banks, pullboxes and manholes, before installation.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Before performing any trenching locate existing underground utilities:
      a. As specified in Section 33_05_01 - Subsurface Utility Engineering.
         1) Determine underground utility horizontal and vertical location by at least one of the following methods:
            a) Soft excavation.
            b) Local utility location service, CALL BEFORE YOU DIG, or equal.

B. Scheduling:
   1. Schedule a coordination meeting to adjust duct bank configurations and routing for each duct bank section after trenching and exposure of any underground utilities withing the vicinity of the duct bank route. Meeting shall determine the final configuration of the duct bank before installation.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Duct bank sections indicated on the Drawings are an initial arrangement and may need to be modified due to existing Site conditions, existing underground utilities, and infrastructure.
   1. Reorganize duct bank section with approval of the Engineer.
   2. Make changes required to accommodate duct bank configuration and routing changes due to field conditions.
      a. Where changes in a duct bank configuration extend to a manhole or handhole, coordinate manhole/handhole blockouts and size with the new configuration.

B. Provide location and protection of existing underground utilities, duct bank, trenching, forming, rebar, spacers, conduit, concrete, backfill, and compaction necessary for the complete installation of the duct banks.

C. Provide reinforced concrete duct banks for conduits installed below grade, on the Site, below structures, or in contact with the earth, unless otherwise indicated on the Drawings.

2.02 MANUFACTURERS

A. Conduit spacers:
   1. One of the following or equal:
      a. Cantex.
      b. Osburn Associates, Inc.

B. Detectable underground marking tape:
   1. One of the following or equal:
      a. Blackburn Manufacturing Co.
      b. Panduit.

C. Pull line:
   1. One of the following or equal:
      a. Arnco.
      b. Greenlee.
      c. Osburn Associates, Inc.

D. Duct seal:
   1. The following or equal:
      a. O-Z/Gedney type DUX.

2.03 MATERIALS

A. Provide conduit as specified in Section 26_05_33 - Conduits.

B. Provide reinforcing steel as specified in Section 03_20_00 - Concrete Reinforcing:
   1. Provide minimum Number 4 reinforcing steel.

C. Concrete:
   1. Mix requirements as specified in Section 03_30_00 - Cast-in-Place Concrete.
   2. Provide a red-oxide conduit encasement coloring agent as specified in Section 03_30_00 - Cast-in-Place Concrete.

2.04 MANUFACTURED UNITS

A. Conduit spacers:
   1. Recommended by the conduit manufacturer or specified above.
   2. Saddle type.
   3. Non-metallic, non-corrosive, non-conductive.
   4. Interlocking type:
      a. Vertical interlocking.
      b. Horizontal interlocking.
   5. Suitable for concrete encasement.
   6. Molded-in rebar holder.
   7. Accommodates 2-inch through 6-inch conduit sizes.
   8. Relieves the conduit from both horizontal and vertical stresses.

B. Pull line:
   1. Minimum 1/4-inch wide, flat design.
   2. Polyester.
   3. Minimum pulling strength 1,200 pounds.
   4. Sequential footage markings.

C. Detectable marking tape:
   1. Locatable by a cable or metal detector from above the undisturbed grade.
   2. Aluminum core laminated between polyethylene film.
   3. 6-inch-wide red tape imprinted with black lettering stating “CAUTION - BURIED ELECTRIC LINE BELOW”, or equivalent.

D. Duct seal:
   1. Non-hardening sealing compound.
   2. Flexible, can be applied by hand.
   3. UL Listed for use with installed conductors.

PART 3 EXECUTION

3.01 INSTALLATION

A. Duct banks:
   1. Encased in concrete at least 24 inches below finish grade, unless otherwise indicated on the Drawings.
   2. Damage minimization:
      a. Conduit should not be left exposed in an open trench longer than is necessary.
      b. Protect underground duct banks against damage during pouring of concrete or backfilling.
   3. Plastic conduit fittings to be joined should be exposed to the same temperature conditions for a reasonable length of time before assembly.
   4. Provide No. 4/0 American Wire Gauge bare copper ground wire the entire length of duct bank and bond to the grounding system at each end of the duct bank and every 20 feet to steel reinforcing bar:
      a. Where duct bank terminates at structures with a grounding electrode, bond duct bank ground wire to the grounding electrode.
      b. Where duct bank terminates at electrical equipment, bond duct bank ground wire to the equipment ground bus.
      c. Where duct bank terminates at structure without either a grounding electrode or electrical equipment, provide ground rod adjacent to structure and bond duct bank ground wire to ground rod.
   5. Install underground ducts to be self-draining:
      a. Slope duct banks away from buildings to manholes, handholes, or pullboxes.
      b. Slope duct banks uniformly from manholes, handholes, or pullboxes to manholes, handholes, or pullboxes or both ways from high points between manholes, handholes, or pullboxes.
      c. Slope a minimum of 1/4 inch per 10 feet.
   6. Where new duct banks join to existing manholes, handholes, or pullboxes, make the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions, as indicated on the Drawings.
   7. Install pull line in spare conduits:
      a. Provide adequate pull line at both ends of conduits to facilitate conductor pulling.
      b. Cap above ground spare conduit risers at each end with screw-on conduit caps.

B. Trenching:
   1. Perform as specified in Section 31_23_35 - Trenching.
   2. Trench must be uniformly graded with the bottom rock free and covered with select material.
   3. Whenever possible, use the walls of the trench as forms for concrete encasement:
      a. Forms are required where the soil is not self-supporting.
   4. Damage occurring to existing ducts, conduits, cables, and other utilities during duct bank installation shall be remediated to the satisfaction of the Owner.

C. Duct spacing:
   1. Separate conduits with manufactured plastic spacers using a minimum space between the outside surfaces of adjacent conduits of 2 inches, unless otherwise indicated on the Drawings:
   2. Install spacers to maintain uniform spacing of duct assembly a minimum of 4 inches above the bottom of the trench during concrete pour. Install spacers on 8-foot maximum intervals:
      a. Due to some distortion of conduit from heat, and other means, it may be necessary to install extra spacers within the duct bank:
         1) Install the intermediate set of spacers within normal required spacing to maintain the proper horizontal clearance:
            a) Clearance is required to allow the proper amount of concrete to infiltrate vertically among the duct to ensure proper protection.
   3. Spacers shall not be located at the center of a bend:
      a. Locate spacer in the tangent, free of the coupling on fabricated bends.
      b. Locate spacers midway between the tangent and the center bend on trench formed sweeps.

D. Terminating:
   1. Use bell ends in duct at entrances into cable vaults.
   2. Make conduit entrances into cable vaults tangential to walls of cable vault.
   3. Form trapezoidal transitions between duct bank and cable vaults as needed in order to ensure adequate cable bending radius for the duct bank-to-vault transition.
   4. Install duct seal in all conduits, including spare conduits, at both ends. Form by hand to conduit and around cables to develop moisture barrier.

E. Concrete:
   1. Install concrete as specified in Section 03_30_00 - Cast-in-Place Concrete.
   2. Provide tie wires as specified in Section 03_20_00 - Concrete Reinforcing to prevent displacement of the conduits during pouring of concrete:
      a. Tie wire shall not act as a substitute for spacers.
   3. Install minimum 3-inch cover around conduit and rebar.
   4. Consolidation of encasement concrete around duct banks shall be by hand puddling. Mechanical vibrators are acceptable for use outside of the rebar cage.
   5. Conduit is subject to temperature rise. As concrete cures, allow the free end to expand by pouring the concrete from the center of the run or from one tie in point.

F. Marking tape:
   1. Install a detectable marking tape 12 inches above the duct bank the entire length of the duct bank.

G. For conduit installations beneath building slabs:
   1. Duct banks shall be continued under building slabs to the final destination of the conduits.
      a. Construct separate duct banks as required.
      b. Concrete for encasement under building slabs need not be colored red.
      c. For duct banks crossing under building footers or foundations, install the top of the duct bank a minimum of 12 inches below the footer.
      d. Where duct banks enter through building walls, foundation walls, stem walls, etc., make connections as indicated on the Drawings.
      e. Where duct banks terminate with conduit risers entering building walls, install an expansion/deflection fitting or a flat-wise elbow (elbow parallel to building wall) in order to accommodate differential movement between the conduits and structure.

H. Restore surfaces to their original condition as specified in Section 32_01_15 - Pavement Restoration and Rehabilitation unless otherwise specified.

3.02 CLEANING

A. Clean conduits of dirt and debris by use of an appropriately sized steel mandrel no less than 1/2 inch smaller than the inside diameter of the conduit.

3.03 PROTECTION

A. Provide shoring and pumping to protect the excavation and safety of workers.

B. Protect excavations with barricades as required by applicable safety regulations.

END OF SECTION

SECTION 26_05_53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Identification of electrical equipment, devices and components.
   2. Material, manufacturing and installation requirements for identification devices.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

C. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Nameplates:
      a. Color.
      b. Size:
         1) Outside dimensions.
         2) Lettering.
      c. Material.
      d. Mounting means.
   2. Nameplate schedule:
      a. Show exact wording for each nameplate.
      b. Include nameplate and letter sizes.
   3. Wire numbers:
      a. Manufacturer’s catalog data for wire labels and label printer.

C. Record documents:
   1. Update the conduit schedule to reflect the exact quantity of wire numbers, including spares and destination points for all wires.

1.04 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.05 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Nameplates:
   1. Provide for control panel operator devices (e.g., pushbuttons, selector switches, pilot lights, etc.):
      a. Same material and same color and appearance as the device nameplates to achieve an aesthetically consistent and coordinated system.

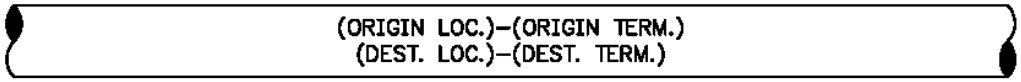
2.02 DESIGN AND PERFORMANCE CRITERIA

A. Nameplates:
   1. Provide for each piece of electrical equipment, device, control panel, and control panel components.
   2. Identical style, color, and material throughout the facility.
   3. Device nameplates information:
      a. Equipment tag number as indicated on the Drawings.

B. Wire numbers:
   1. Coordinate the wire numbering system with vendors of equipment so that every field wire has a unique number associated with it for the entire system:
      a. Correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
      b. Correspond to the terminal block number to which they are attached in the control panel.
      c. Internal panel wires on a common terminal shall have the same wire number.
      d. Multi-conductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. Multi-conductor and instrumentation cables shall be identified at pull points as described above:
         1) Label armored multi-conductor cable using the conduit number as indicated on the Drawings, following the requirements for conduit markers specified in Section 26_05_33 - Conduits.
   2. Provide the following wiring numbering schemes throughout the Project for field wires between process control module (PCM), vendor control panels (VCP), motor control centers (MCC), field starters, field instruments, etc.



OR:



Where:

ORIGIN LOC. = Designation for originating panel or device

ORIGIN TERM. = Terminal designation at originating panel or device

DEST. LOC. = Designation for destination panel or device

DEST. TERM. = Terminal designation at destination panel or device or PLC

3. I/O address at destination panel:
   a. Identify equipment and field instruments as the origin.
   b. PCMs are always identified as the destination.
   c. Location is the panel designation for VCP, LCP, or PCM. For connections to MCCs, location is the specific starter tag and loop number. Location is the tag and loop number for motor starters, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
   d. Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multi-conductor cables, all terminal numbers shall be shown, separated by commas.
   e. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (e.g., T1, T2, T3, etc.).
   f. Terminal designations at PCMs where the field conductor connects to field terminal blocks for a PLC input or output shall be the PLC address (Note: The following PLC I/O numbering scheme is typical for Allen-Bradley. The numbering scheme should be modified to match that of the actual PLC manufacturer used for the Project):

      Discrete Point: W:X:Y/Z.

      Analog Point: W:X:Y.Z.

      Where:

      W = I for input, O for output.

      X = PLC number (1, 2, 3…)

      Y = Slot number (01, 02, 03…)

      Z = Terminal number (00, 01, 02…) for a discrete point or a word number for an analog point (1, 2, 3…)

   g. Terminal designations at PCMs where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (e.g., C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have and capital letter suffix starting with "A" (e.g., C0010A).
4. **Case 1**: Vendor control panel (VCP) to process control module (PCM):

   Field wire number/label: A-B/C-D:

   A = Vendor control panel number without hyphen (VCP#)

   B = Terminal number within VCP (manufacturer's or vendor's standard terminal number)

   C = Process control module number without hyphen (PCM#)

D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a “C” prefix if not connected directly to a PLC I/O point (C0010)

Examples:

VCP#-10/PCM#-I: 1:01/01

VCP#-10/PCM#-O: 1:10/07

VCP#-10/PCM#-C0100

5. **Case 2**: Field instrument to process control module (PCM):

Field wire number/label: E-F/C-D:

C = Process control module number without hyphen (PCM#)

D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a “C” prefix if not connected directly to a PLC I/O point (C0010)

E = Field mounted instrument tag and loop numbers without hyphen (EDV#)

F = Manufacturer’s standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma

Examples:

TIT#-2,3/PCM#-I: 1:01.1

TSH#-1/PCM#-I: 2:01/00

6. **Case 3**: Motor control center (MCC) to process control module (PCM):

Field wire number/label: G-B/C-D:

B = Terminal number within Motor Control Center (manufacturer’s or vendor’s standard terminal number)

C = Process control module without hyphen (PCM#)

D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a “C” prefix if not connected directly to a PLC I/O point (C0010)

G = Actual starter designation in the motor control center without hyphen (MMS#)

Examples:

MMS#-10/PCM#-I: 1:01/01

MMS#-10/PCM#-O: 1:10/07

MMS#-10/PCM#-C0100

7. **Case 4**: Motor control center (MCC) to vendor control panel (VCP):

   Field wire number/label: G-B/A-B:

   A = Vendor control panel number without hyphen (VCP#)

   B = Terminal number within motor control center or vendor control panel (manufacturer's or vendors standard terminal number)

   G = Actual starter designation in the motor control center without hyphen (MMS#)

   Example:

   MMS#-X2/VCP#-10

8. **Case 5**: Motor leads to a motor control center (MCC):

   Field wire number/label: H-I/G-B:

   B = Terminal number within motor control center (manufacturer's standard terminal number)

   G = Actual starter designation in the motor control center without hyphen (MMS#)

   H = Equipment tag and loop number without hyphen (PMP#)

   I = Motor manufacturer's standard motor lead identification (e.g., T1, T2, T3, etc.)

   Example:

   PMP-#-T3/MMS#-T3

9. **Case 6**: Remote or separately mounted starter or variable frequency drive (VFD) to process control module (PCM):

   Field wire number/label: J-B/C-D:

   B = Terminal number within starter or variable frequency drive (manufacturer's standard terminal number)

   C = Process control module number without hyphen (VCP#)

   D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

   J = Starter or variable frequency drive tag and loop number without hyphen (MMS#)

   Examples:

   MMS#-10/PCM#-I: 1:01/01

   MMS#-10/PCM#-O: 2: 10/07

   MMS#-10/PCM#-C0010

10. Identify spare conductors as required for other field wires with an "S" prefix:

    Example:

    S MMS#-10/PCM#-C011

2.03 MANUFACTURERS

A. Nameplates and signs:
   1. One of the following or equal:
      a. Brady.
      b. Seton.

B. Conductor and cable markers:
   1. Heat-shrinkable tubing:
      a. One of the following or equal:
         1) Brady.
         2) Kroy.
         3) Panduit.
         4) Raychem.

C. Conduit and raceway markers:
   1. Stainless steel: One of the following or equal:
      a. Panduit.

2.04 MATERIALS

A. Nameplates:
   1. Colors:
      a. Warning: White-center, red face.
      b. Other: Black-center, white face.
   2. Laminated plastic engraving stock:
      a. 3/32-inch thick material.
      b. 2-ply.
   3. With chamfered edges.
   4. Lettering:
      a. Block style engraved characters of adequate size to be read easily from a distance of 6 feet.
      b. Minimum letter height: 1/8 inch.

B. Signs:
   1. Automatic equipment and high voltage signs:
      a. Suitable for exterior use.
      b. In accordance with OSHA regulations.

C. Conductor and cable markers:
   1. Lettering:
      a. Machine printed black characters on white tubing.
      b. Minimum letter height: 10-point type or larger.

D. Conduit and raceway markers:
   1. Stainless steel:
      a. Type 304 or 316.
      b. Minimum letter height: 3/16 inch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Nameplates:
   1. Attach to equipment with rivets, bolts, or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
   2. Provide for each disconnecting means with the following:
      a. Equipment served, voltage, and fuse size as required.
      b. Identification of the circuit source that supplies the disconnecting means.
   3. On NEMA Type 4, NEMA Type 4X, or NEMA Type 7 enclosures, use epoxy-based cement to attach nameplates.
   4. Aligned and level or plumb to within 1/64 inch over the entire length:
      a. Misaligned or crooked nameplates shall be remounted or provide new enclosures at the discretion of the Engineer.

B. Conductor and cable markers:
   1. Apply before termination.
   2. Heat-shrinkable tubing:
      a. Shrunk using a heat gun that produces low temperature heated air.
      b. Tight on the wire after it has been heated.
      c. Characters shall face the open panel and shall read from left to right or top to bottom.
      d. Marker shall start within 1/32 inch of the end of the stripped insulation point.

C. Conduit markers:
   1. Furnish and install markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system:
      a. Markings shall match the conduit schedule.
   2. Mark conduits at the following locations:
      a. Each end of conduits that are greater than 10 feet in length.
      b. The middle of conduits that are 10 feet or less in length.
      c. Where the conduit penetrates a wall, structure, manhole, or handhole.
         1) Marker shall be non-metallic with stainless steel hardware.
      d. Where the conduit emerges from the ground, slab, etc.
   3. Mark conduits after the conduits have been fully painted.
   4. Position conduit markers so that they are easily read from the floor.
   5. Attach stainless steel tags with stainless steel cable ties.
   6. Mark conduits before construction review by the Engineer for punch list purposes.
   7. Label intrinsically safe conduits in accordance with the requirements of the NEC.

D. Signs and labeling:
   1. Furnish and install permanent warning signs at mechanical equipment that may be started automatically or from remote locations:
      a. Fasten warning signs with round head stainless steel screws or bolts.
      b. Locate and mount in a manner to be clearly legible to operations personnel.

2. Furnish and install permanent and conspicuous warning signs on equipment (front and back), doorways to equipment rooms, pull boxes, manholes, etc., where the voltage exceeds 600 volts.
3. Furnish and install warning signs on equipment that has more than one source of power.
    a. Warning signs to identify every panel and circuit number of the disconnecting means of external power sources.
4. Place warning signs on equipment that has 120 VAC control voltage source used for interlocking.
    a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.
5. Label service entrance equipment, switchgear, switchboards, MCCs, panelboards, and transfer switches with the available short circuit current, equipment label, and date of application in accordance with NEC. Coordinate with Section 26_05_74 - Electrical System Studies for available fault current data.

3.02 FIELD QUALITY CONTROL

A. Replace any nameplates, signs, conductor markers, cable markers, or raceway labels that in the sole opinion of the Engineer do not meet the Engineer's aesthetic requirements.

END OF SECTION

SECTION 26_05_74

ELECTRICAL SYSTEM STUDIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Short-circuit fault analysis studies.
   2. Protective device coordination study.
   3. Machine and electrical system settings.
   4. Arc-flash hazard study.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations.

C. National Fire Protection Association (NFPA):
   1. 70E - Standard for Electrical Safety in the Workplace.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Final electrical system study report: The delegated design final report that incorporates installed cable lengths, and all construction changes.
   2. Initial short-circuit fault analysis: An analysis done based on the Drawings and utility information. The purpose is to identify the available fault current at each piece of equipment to make sure it is properly rated.
   3. Modified: Equipment with load additions or with loads being removed that affect fault current, include new overcurrent protective devices that require settings and device coordination, or require additional/removal/replacement of arc flash labels.
   4. Preliminary electrical system studies:
      a. If startup and sequencing occur before the final study is completed, perform a preliminary study as needed to determine temporary protective device settings.
      b. Preliminary studies will not be reviewed by the Engineer but shall be submitted for record.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Signed and sealed electrical system study reports.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Credentials of the individual(s) performing the study and the individual in responsible charge of the study.

C. General:
   1. Format and quantity:
      a. 3 bound copies of all final reports.
      b. 3 complete sets of electronic files on CD or DVD media, including the electrical system model(s), configuration files, custom libraries, and any other files used to perform the studies and produce the reports. Also provide an electronic version of the bound reports in PDF format.
   2. One-line diagrams:
      a. The following information shall be included at a minimum:
         1) Motor horsepower.
         2) Transformer data:
            a) kVA.
            b) Configuration.
         3) Cable data:
            a) Insulation.
            b) Size.
            c) Length.
      b. Fully legible at 11-inch by 17-inch size.

D. Initial short-circuit fault analysis:
   1. Based on the Contract Documents and electric utility information.
   2. Include a description of all operating scenarios.
   3. One-line diagrams.
   4. Indicate the estimated available short-circuit current at the line side terminals of each piece of equipment covered by the scope of the study.
      a. Measure conductor lengths from the Drawings. Use of arbitrary short conductor lengths is not allowed.
      b. Provide a list of assumptions used in the initial study.

E. Delegated Design final studies and reports:
   1. Include the following sections at a minimum:
      a. Copies of correspondence and data obtained from the electric utility company.
      b. Letter certifying the inspection and verification of existing equipment and incorporation of applicable RFI's and change orders.
      c. Short-circuit fault analysis:
         1) Modify the initial short-circuit fault analysis as follows:
            a) Utilize the actual equipment provided on the Project.
            b) Utilize conductor lengths based on installation.
            c) Update one-line diagrams to show as-built conditions.
         2) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
         3) Normal system connections and those that result in maximum fault conditions.

4) Tabulation of circuit breaker, fuse, and other protective device ratings compared to maximum calculated short-circuit duties.
5) Fault current calculations for the cases run, including a definition of terms and guide for interpretation of computer software printouts.

d. Protective device coordination study shall include:
1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
2) List requirements used in the selection and setting criteria for any protective devices.
3) TCCs graphically indicating the coordination proposed for the system on log-log graphs:
a) All TCCs shall be in color.
4) Tabulation of relay, fuse, circuit breaker, and other protective devices in graphical form with a one-line diagram to display area coordination.
5) Where coordination could not be achieved, an explanation shall be included in the report to support the statement along with recommendations to improve coordination. Recommended equipment modifications or settings shall be in a tabulated form.
6) Protective device settings in a tabulated format.

e. Include in the arc-flash hazard study:
1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
2) Normal system connections and those that result in maximum arc-flash conditions.
3) Arc-flash raw data, calculations, and assumptions.

f. Form and format of arc-flash labels.
1) Label data:
a) Identifying the content of each label.
b) Identifying the location of each label.

F. Signature page identifying the name for the person entering the setting and a representative of the Contractor for each protective device requiring setting or adjustment.

G. Submit course outline for Owner Training.

1.06 QUALITY ASSURANCE

A. Qualifications of the entity responsible for electrical system studies:
1. Short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall be performed with the aid of a digital computer program:
a. Point-to-point calculations are not acceptable.

B. Qualifications of the entity responsible for electrical system studies:
1. The studies shall be performed, stamped, and signed by a professional engineer registered in the state of Washington.
2. A minimum of 5 years of experience in power system analysis is required for the individual in responsible charge of the studies.

C. The study shall be performed by qualified independent firm or the equipment manufacturer of the new MCC-42001.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. The individual performing the studies shall visit the site and collect necessary field data in order to perform and complete comprehensive electrical system studies.
   2. Obtain, for all equipment, the required data for preparation of the study, including, but not limited to:
      a. Transformer kilovolt-ampere (kVA), nameplate data, and impedances.
      b. Generator impedances, kilovolt-ampere (kVA), and voltage.
      c. Generator decrement curves.
      d. Bus withstand ratings.
      e. Cable and bus data.
      f. Protective device taps, time dials, instantaneous pickups, and time-delay settings.
      g. As-built lengths for new wire and cable installations covered by the studies.
      h. Grounding schemes (solidly grounded or resistive grounded).
   3. Obtain the electric utility information on the minimum and maximum available fault current, minimum and maximum utility impedances, utility protective device settings, including manufacturer and model number, interrupting ratings, X/R ratios, and model information one level above the point of connection:
      a. Utility tolerances and voltage variations.
   4. Obtain equipment layouts and configurations from the manufacturer's final Submittal requirements and project layout drawings as required.
   5. Bus and conductor data:
      a. Use impedances of the actual installed or specified conductors, unless otherwise indicated.
      b. Use cable and bus impedances calculated at 25 degrees Celsius, unless otherwise indicated.
      c. Use 600-volt cable reactance based on typical dimensions of actual installed or specified conductors, unless otherwise indicated.
      d. Use bus withstand values for all equipment having buses.

B. Use medium-voltage cable reactance based on typical dimensions of shielded cables with 133 percent insulation levels, unless otherwise indicated.

C. Certification:
   1. Submit written certification signed by the professional engineer conducting the study, equipment supplier, and electrical subcontractor, stating that the data used in the study is correct and captures all RFIs, as-builts, and change orders affecting the study.

D. Meetings:
   1. Electrical system study meetings:
      a. As specified in Section 01_31_19 - Project Meetings.
      b. The individual conducting the electrical system studies leads the meeting.
      c. Meet with the Owner and Engineer 3 times.
      d. First meeting:
         1) Discuss the scope of the studies.
         2) Confirm electrical system operating modes.

3) Confirm assumptions to be used in the electrical system study with the Owner, including, but not limited to:
    a) Maximum protective device fault clearing time.
4) Discuss the Owner's operational requirements for both normal operation and maintenance.

e. Second meeting:
1) Inform the Owner of the results of the study and impacts on normal operation and maintenance, including:
    a) Protective device coordination problems and recommended solutions.
    b) Explanation of the arc-flash hazard study results and its potential impact on operations.
    c) Recommendations for reduction of arc-flash category levels, including reduction of protective device settings or changes in operational practices.

f. Final meeting:
1) Prior to substantial completion.
2) Discuss changes to the studies based on the previous meeting.
3) Discuss with the Owner how changes to the electrical system may change the arc-flash hazard category.

E. Sequencing:
1. Below is an outline of the typical work sequence. Proposed changes to the work sequence may be reviewed and approved by the Engineer.
    a. First system study meeting.
    b. Submit the initial short-circuit fault analysis study before submittal of any electrical equipment.
        1) Only the initial short-circuit results will be reviewed.
    c. Site visit to gather data on the existing facility systems for all studies:
        1) Make multiple trips as required to obtain data for the short-circuit fault analysis, protection device coordination, and arc flash hazard studies.
    d. Conduct preliminary protective device coordination analysis and overcurrent device settings as required to accommodate project and sequencing.
    e. Submit the draft short-circuit fault analysis, protective device coordination, and arc-flash hazard studies after the approval of all electrical equipment.
    f. Second system study meeting for preliminary results.
    g. Update the model with changes to the electrical system made during start-up and commissioning.
    h. Final system study meeting.
    i. Submit the final electrical system studies.
    j. Label equipment with approved arc-flash labels.
    k. Owner Training.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. General study requirements:
   1. Scope:
      a. Short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall include all new and modified existing equipment in the power distribution system, including, but not limited to:
         1) Utility equipment (utility transformer and primary protective device).
         2) Available utility fault contribution current.
         3) All electrical equipment, including:
            a) Dry-type transformers.
            b) 240- and 208-volt panelboards.
         4) Generators.
         5) Motors.
         6) Vendor control panels.
         7) HVAC equipment.
      b. Study scenarios:
         1) Include all possible electrical system configurations, for example:
            a) Operation on normal (utility) source.
            b) Operation on generator source.
            c) Main-breakers closed; tie-breaker open.
            d) Either main-breaker open; tie-breaker closed.
   2. Motors:
      a. Each motor shall be individually modeled:
         1) Grouping of motors for fault contribution current is not acceptable.
      b. Motors with variable frequency drives (VFDs) may be assumed to have no contribution to fault current, unless VFDs are equipped with bypass contactors.
         1) If VFDs are equipped with bypass contactors, perform the fault current and arc flash study assuming 20 percent of bypass contactors are in the closed position.
   3. Use the equipment, bus, and device designations as indicated on the Drawings for all studies.

B. Short-circuit fault analysis study additional requirements:
   1. Calculate 3-phase bolted fault, line-to-line fault, line-to-ground fault, double line-to-ground fault, short-circuit 1/2 cycle momentary symmetrical and asymmetrical RMS, 1-1/2 to 4 cycle interrupting symmetrical RMS, and 30-cycle steady-state short-circuit current values at each piece of equipment in the distribution system.
   2. Evaluate bus bracing, short-circuit ratings, fuse interrupting capacity and circuit-breaker-adjusted interrupting capacities against the fault currents, and calculate X/R values:
      a. Identify and document all devices and equipment as either inadequate or acceptable.

3. Calculate line-to-ground and double line-to-ground momentary short-circuit values at buses having ground-fault devices.
4. Provide calculation methods, assumptions, one-line diagrams, and source impedance data, including utility X/R ratios, typical values, recommendations, and areas of concern.

C. Protective device coordination study additional requirements:
   1. Furnish protective device settings for functions indicated on the Drawings, including, but not limited to:
      a. Current.
   2. Provide log-log form time-current curves (TCC) graphically indicating the coordination proposed for the system:
      a. Include with each TCC a complete title and one-line diagram with legend identifying the specific portion of the system covered by the particular TCC:
         1) Typical TCCs for identical portions of the system, such as motor circuits, are acceptable as allowed by the Engineer.
      b. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics:
         1) These details can be included on the TCC.
      c. Include a detailed description of each protective device tap, time dial, pickup, instantaneous, and time delay settings:
         1) These details can be included on the TCC.
   3. TCCs shall include all equipment in the power distribution system where required to demonstrate coordination. Include utility relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, transformer characteristics, motor and generator characteristics, and characteristics of other system load protective devices:
      a. Include devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, main breaker in branch panelboards, and fused disconnect switches.
      b. Provide ground fault TCCs with adjustable settings for ground fault protective devices.
      c. Include manufacturing tolerances and damage bands in plotted fuse and circuit breaker characteristics.
      d. On the TCCs, show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and transformer damage curves.
      e. Cable damage curves.
      f. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed based on the short-circuit fault analysis study.
      g. Coordinate time interval medium-voltage relay characteristics with upstream and downstream devices to avoid nuisance tripping.
   4. When site generation (including cogeneration, standby, and emergency generators) is part of the electrical system, include phase and ground coordination of the generator protective devices:
      a. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices.
   5. Suggest modifications or additions to equipment rating or settings in a tabulated form.

D. Arc-flash hazard study additional requirements:
    1. Include the calculated arc-flash boundary and incident energy (calories/square centimeter) at each piece of equipment in the distribution system:
        a. Perform study with 15 percent arcing fault variation in accordance with IEEE 1584.
        b. Perform arc-flash calculations at minimum and maximum utility and generator fault contributions.
        c. Perform arc-flash calculations for both the line side and load side of the switchgear, switchboard, motor control center, and panelboard main breakers.
        d. Perform arc-flash calculations for short-circuit scenarios with all motors on for 3 to 5 cycles and with all motors off.
    2. Provide executive summary of the study results:
        a. Provide summary based upon worst case results.
    3. Provide a detailed written discussion and explanation of the tabulated outputs:
        a. Include all scenarios.
    4. Provide alternative device settings to allow the Owner to select the desired functionality of the system:
        a. Minimize the arc-flash energy by selective trip and time settings for equipment maintenance purposes.
        b. Identify the arc-flash energy based upon the criteria of maintaining coordination and selectivity of the protective devices.

2.02 MANUFACTURERS

A. Electrical system study software: One of the following or equal:
    1. Operation Technology, Inc., ETAP.
    2. SKM Systems Analysis, Powertools.

2.03 COMPONENTS

A. Arc-flash hazard labels:
    1. Dimensions:
        a. Minimum 5 inches by 3.5 inches.
    2. Materials:
        a. Polyester with polyvinyl polymer over-laminate.
        b. Self-adhesive.
        c. Resistant to:
            1) UV.
            2) Chemicals and common cleaning solvents.
            3) Scuffing.
            4) Wide temperature changes.
    3. Contents:
        a. Short-circuit bus identification.
        b. Calculated incident energy (calories/square centimeter) range:
            1) Based on worst-case study results.
        c. Arc-flash protection boundary.

d. Shock hazard boundary:
    1) Contractor may provide separate labels for indication of the shock hazard boundary.
e. Fed from:
    1) Identify the tag number of the upstream equipment providing power.

4. Color scheme:
    a. For locations above 40 calories/square centimeter:
        1) White label with red “DANGER” strip across the top.
        2) Black lettering.
    b. For locations below 40 calories/square centimeter:
        1) White label with orange “WARNING” strip across the top.
        2) Black lettering.

PART 3 EXECUTION

3.01 INSTALLATION

A. After review and acceptance of the arc-flash hazard study by the Engineer, install arc-flash hazard labels:
    1. At all locations required by NFPA, ANSI, or IEEE standards.
    2. At a minimum, in the following locations:
        a. Front of each main or incoming service compartment.
        b. Front of each low-voltage switchgear section.
        c. Front of each medium-voltage circuit breaker door.
        d. Front of each accessible auxiliary or conductor compartment.
        e. Each accessible rear or side vertical section.
        f. Each motor control center vertical section.
        g. Each panelboard covered by the study.
        h. Each control panel, individual starter or VFD, or other equipment covered by the scope of the study.

3.02 FIELD QUALITY CONTROL

A. Individual performing the arc-flash hazard study shall direct the installation of the arc-flash hazard labels:
    1. Remove and replace any improperly applied labels.
    2. Repair the equipment finish damaged by removal of any label.
    3. Install labels level or plumb across the entire dimension of the label.

3.03 ADJUSTING

A. After review and acceptance of the draft arc-flash hazard study and protective device coordination study by the Engineer, adjust protective device settings in accordance with final study prior to equipment energization.
    1. Devices that require power for configuration may be set during energization, but before any subfed loads are energized.
    2. Ensure that settings for upstream equipment are set prior to energizing downstream devices. Provide documentation that protective devices are set in accordance with the study recommendation.

END OF SECTION

SECTION 26_06_01

CONDUIT SCHEDULE
AREAS 50 AND 340

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 26_05_00 and Section 26_05_33.

B. Cable requirements and definitions:
   1. As defined in Section 26_05_00 and Section 26_05_19.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. 3/CS#16: 3 conductor, 16 gauge, twisted shielded triplet.
   4. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   5. VFD: Shielded VFD cable with integral ground.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREAS 50 AND 340

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

AREA 50 TUNNEL AND AREA 340 SECONDARY SLUDGE PUMP STATION

ENGINEER	**TDT**
REVISION	**0**
DATE	10/4/24

CONDUIT			CONDUCTORS			GROUND						
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**		**DESCRIPTION**		**CONNECTING SEGMENTS**
C-050-210	050E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR:		LCP-34033	C-050-211
									TO:		CONDUIT TEE	
										8 #14	>> LCP-34033 CONTROL	
										2 #14	>> SPARE	
C-050-211	050E102	1.5"	20	#14	XHHW-2	1	#14	XHHW-2	FR:		CONDUIT TEE	C-050-250
									TO:		JBOX	
										8 #14	>> LCP-34033 CONTROL	C-050-210
										8 #14	>> LCP-34034 CONTROL	C-050-220
										2 #14	>> SPARE	C-050-210
										2 #14	>> SPARE	C-050-220
C-050-212	050E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR:		PSH-34033	C-050-216
									TO:		CONDUIT TEE	
										2 #14	>> PSH-34033 CONTROL	
C-050-215	050E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR:		EDR-34033	C-050-216
									TO:		CONDUIT TEE	
										8 #14	>> EDR-34033 CONTROL	
										2 #14	>> SPARE	
C-050-216	050E102	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR:		CONDUIT TEE	C-050-250
									TO:		JBOX	
										2 #14	>> PSH-34033 CONTROL	C-050-212
										8 #14	>> EDR-34033 CONTROL	C-050-215
										2 #14	>> SPARE	C-050-215
C-050-220	050E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR:		LCP-34034	C-050-211
									TO:		CONDUIT TEE	
										8 #14	>> LCP-34034 CONTROL	
										2 #14	>> SPARE	
C-050-222	050E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR:		PSH-34034	C-050-226
									TO:		CONDUIT TEE	
										2 #14	>> PSH-34034 CONTROL	
C-050-225	050E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR:		EDR-34034	C-050-226
									TO:		CONDUIT TEE	
										8 #14	>> EDR-34034 CONTROL	
										2 #14	>> SPARE	
C-050-226	050E102	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR:		CONDUIT TEE	C-050-250
									TO:		JBOX	
										2 #14	>> PSH-34034 CONTROL	C-050-222
										8 #14	>> EDR-34034 CONTROL	C-050-225
										2 #14	>> SPARE	C-050-225
C-050-230	050E102	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR:		CONDUIT TEE	C-050-250
									TO:		JBOX	
										4 #14	>> TSH/MWH-34033 CONTROL	P-050-200
C-050-240	050E102	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR:		CONDUIT TEE	C-050-250
									TO:		JBOX	
										4 #14	>> TSH/MWH-34034 CONTROL	P-050-201
C-050-250	050E101	2"	52	#14	XHHW-2	1	#14	XHHW-2	FR:		JBOX	
	050E102								TO:		CONDUIT TEE	
	340E101									8 #14	>> LCP-34033 CONTROL	C-050-211
										8 #14	>> LCP-34034 CONTROL	C-050-211
										2 #14	>> PSH-34033 CONTROL	C-050-216
										8 #14	>> EDR-34033 CONTROL	C-050-216
										2 #14	>> PSH-34034 CONTROL	C-050-226
										8 #14	>> EDR-34034 CONTROL	C-050-226
										4 #14	>> TSH/MWH-34033 CONTROL	C-050-230
										4 #14	>> TSH/MWH-34034 CONTROL	C-050-240
										2 #14	>> SPARE	C-050-211
										2 #14	>> SPARE	C-050-211
										2 #14	>> SPARE	C-050-216
										2 #14	>> SPARE	C-050-226
C-050-255	340E101	1.5"	28	#14	XHHW-2	1	#14	XHHW-2	FR:		CONDUIT TEE	
									TO:		VFD-34033	
										12 #14	>> LCP-34033 CONTROL	C-050-250
										2 #14	>> PSH-34033 CONTROL	C-050-250
										10 #14	>> EDR-34033 CONTROL	C-050-250
										4 #14	>> TSH/MWH-34033 CONTROL	C-050-250
C-050-256	340E101	1.5"	28	#14	XHHW-2	1	#14	XHHW-2	FR:		CONDUIT TEE	
									TO:		VFD-34034	
										12 #14	>> LCP-34034 CONTROL	C-050-250
										2 #14	>> PSH-34034 CONTROL	C-050-250
										10 #14	>> EDR-34034 CONTROL	C-050-250
										4 #14	>> TSH/MWH-34034 CONTROL	C-050-250

CONDUIT SCHEDULE AREAS 50 AND 340

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

AREA 50 TUNNEL AND AREA 340 SECONDARY SLUDGE PUMP STATION

ENGINEER	**TDT**
REVISION	**0**
DATE	10/4/24

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-050-260	340E102	1"	16	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-34033 TO: CONDUIT TEE 14 #14 >> VFD-34033 CONTROL 2 #14 >> SPARE	C-050-262
C-050-261	340E102	1"	16	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-34034 TO: CONDUIT TEE 14 #14 >> VFD-34034 CONTROL 2 #14 >> SPARE	C-050-262
C-050-262	340E102	1.5"	32	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: ACP-3400 14 #14 >> VFD-34033 CONTROL 14 #14 >> VFD-34034 CONTROL 2 #14 >> SPARE 2 #14 >> SPARE	 C-050-260 C-050-261 C-050-260 C-050-261
P-050-200	050E102	1.5"	1 4	3/C-#8:VFD #14	VFD XHHW-2	1	#14	XHHW-2	FR: P-34033 TO: CONDUIT TEE 1 3/C-#8:VFD >> P-34033 POWER 4 #14 >> TSH/MWH-34033 CONTROL	
P-050-201	050E102	1.5"	1 4	3/C-#8:VFD #14	VFD XHHW-2	1	#14	XHHW-2	FR: P-34034 TO: CONDUIT TEE 1 3/C-#8:VFD >> P-34034 POWER 4 #14 >> TSH/MWH-34034 CONTROL	
P-050-210	050E102	1.5"	1	3/C-#8:VFD	VFD			INTEGRAL	FR: CONDUIT TEE TO: CONDUIT TEE 1 3/C-#8:VFD >> P-34033 POWER	P-050-251 P-050-200
P-050-215	050E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDR-34033 TO: CONDUIT TEE(VIA DISC) 3 #12 >> EDR-34033 POWER	P-050-250
P-050-220	050E102	1.5"	1	3/C-#8:VFD	VFD			INTEGRAL	FR: CONDUIT TEE TO: CONDUIT TEE 1 3/C-#8:VFD >> P-34034 POWER	P-050-251 P-050-201
P-050-225	050E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDR-34034 TO: CONDUIT TEE(VIA DISC) 3 #12 >> EDR-34034 POWER	P-050-250
P-050-250	050E101 050E102 340E101	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: PP-34001 3 #12 >> EDR-34033 POWER 3 #12 >> EDR-34034 POWER	 P-050-215 P-050-225
P-050-251	050E101 050E102 340E101	2"	2	3/C-#8:VFD	VFD			INTEGRAL	FR: CONDUIT TEE TO: CONDUIT TEE 1 3/C-#8:VFD >> P-34033 POWER 1 3/C-#8:VFD >> P-34034 POWER	 P-050-210 P-050-220
P-050-255	340E101	1.5"	1	3/C-#8:VFD	VFD			INTEGRAL	FR: CONDUIT TEE TO: VFD-34033 1 3/C-#8:VFD >> P-34033 POWER	 P-050-251
P-050-256	340E101	1.5"	1	3/C-#8:VFD	VFD			INTEGRAL	FR: CONDUIT TEE TO: VFD-34034 1 3/C-#8:VFD >> P-34034 POWER	 P-050-251
P-050-260	340E102	0.75"	3	#8	XHHW-2	1	#10	XHHW-2	FR: VFD-34033 TO: SG-3401 3 #8 >> VFD-34033 POWER	
P-050-261	340E102	0.75"	3	#8	XHHW-2	1	#10	XHHW-2	FR: VFD-34044 TO: SG-3401 3 #8 >> VFD-34044 POWER	
S-050-210	050E102	0.75"	1	3/CS-#16		1	#14	XHHW-2	FR: LCP-34033 TO: CONDUIT TEE 1 3/CS-#16 >> LCP-34033 SIGNAL	S-050-250
S-050-220	050E102	0.75"	1	3/CS-#16		1	#14	XHHW-2	FR: LCP-34034 TO: CONDUIT TEE 1 3/CS-#16 >> LCP-34034 SIGNAL	S-050-250
S-050-250	050E101 050E102 340E102	0.75"	2	3/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 1 3/CS-#16 >> LCP-34033 SIGNAL 1 3/CS-#16 >> LCP-34034 SIGNAL	 S-050-210 S-050-220

CONDUIT SCHEDULE AREAS 50 AND 340

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

AREA 50 TUNNEL AND AREA 340 SECONDARY SLUDGE PUMP STATION

ENGINEER	**TDT**
REVISION	**0**
DATE	10/4/24

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-050-251	340E102	0.75"	1	3/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	
									TO: VFD-34033	
									1 3/CS-#16 >> LCP-34033 SIGNAL	S-050-250
S-050-252	340E102	0.75"	1	3/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	
									TO: VFD-34034	
									1 3/CS-#16 >> LCP-34034 SIGNAL	S-050-250
S-050-260	340E102	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VFD-34033	S-050-262
									TO: CONDUIT TEE	
									2 2/CS-#16 >> VFD-34033 SIGNAL	
S-050-261	340E102	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VFD-34034	S-050-262
									TO: CONDUIT TEE	
									2 2/CS-#16 >> VFD-34034 SIGNAL	
S-050-262	340E102	1"	4	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	
									TO: ACP-3400	
									2 2/CS-#16 >> VFD-34033 SIGNAL	S-050-260
									2 2/CS-#16 >> VFD-34034 SIGNAL	S-050-261
C-340-110	340E101	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-33088	C-340-115
									TO: JBOX	
									7 #14 >> LCP-33088 CONTROL	
									3 #14 >> SPARE	
C-340-111	340E101	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-33088	C-340-115
									TO: JBOX	
									4 #14 >> FSL-33088 CONTROL	
C-340-112	340E101	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SV-33088	C-340-115
									TO: JBOX	
									2 #14 >> SV-33088 CONTROL	
C-340-113	340E101	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-340-115
									TO: JBOX	
									4 #14 >> TSH/MWH-33088 CONTROL	P-340-100
C-340-114	340E101	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PSL-33088	C-340-115
									TO: JBOX	
									2 #14 >> PSL-33088 CONTROL	
C-340-115	340E101	1.5"	22	#14	XHHW-2	1	#14	XHHW-2	FR: JBOX	
									TO: MCC-3401	
									7 #14 >> LCP-33088 CONTROL	C-340-110
									4 #14 >> FSL-33088 CONTROL	C-340-111
									2 #14 >> SV-33088 CONTROL	C-340-112
									4 #14 >> TSH/MWH-33088 CONTROL	P-340-100
									3 #14 >> SPARE	C-340-110
									2 #14 >> PSL-33088 CONTROL	C-340-114
C-340-120	340E102	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-3401	
									TO: ACP-3400	
									5 #14 >> MCC-3401 CONTROL	
									2 #14 >> SPARE	
P-340-100	340E101	0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: P-33088	
			4	#14	XHHW-2				TO: CONDUIT TEE	
									3 #10 >> P-33088 POWER	
									4 #14 >> TSH/MWH-33088 CONTROL	
P-340-110	340E101	0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: CONDUIT TEE	
									TO: MCC-3401 (VIA DISC)	
									3 #10 >> P-33088 POWER	P-340-100

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 26_06_02

CONDUIT SCHEDULE
AREA 420

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 26_05_00 and Section 26_05_33.

B. Cable requirements and definitions:
   1. As defined in Section 26_05_00 and Section 26_05_18.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. */FO: Fiber optic (* indicates strand count).
   5. CAT6: Category 6 Ethernet cable.
   6. MFR: Manufacturer or vendor furnished cable.
   7. PULL: Pull Rope.
   8. VFD: Shielded VFD cable with integral ground.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SLUDGE STORAGE BUILDING

ENGINEER TDT

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-420-001	420E106	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: ATS-42001 TO: LCP-42020 12 #14 >> ATS-42001 CONTROL	
C-420-003	420E106	1"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SPD1-42001 TO: LCP-42020 2 #14 >> SPD1-42001 CONTROL/ALARM	
C-420-030	420E104	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SV-42001 TO: CONDUIT TEE 2 #14 >> SV-42001 CONTROL	C-420-035
C-420-033	420E104	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SV-42002 TO: CONDUIT TEE 2 #14 >> SV-42002 CONTROL	C-420-035
C-420-035	420E104 420E106	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: LCP-42020 2 #14 >> SV-42001 CONTROL 2 #14 >> SV-42002 CONTROL	 C-420-030 C-420-033
C-420-038	420E106	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: FACP-42001 TO: LP-42001 4 #14 >> FACP-42001 CONTROL	
C-420-039	420E104 420E106	2"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FACP-42001 TO: EXISTING BUILDING 710 MASTER FACP 2 #14 >> FACP-42001 CONTROL	
C-420-040	420E104	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PSL-42001 TO: CONDUIT TEE 2 #14 >> PSL-42001 CONTROL	C-420-051
C-420-043	420E104	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PSL-42004 TO: CONDUIT TEE 2 #14 >> PSL-42004 CONTROL	C-420-044
C-420-044	420E104 420E106	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: VFD-42002 2 #14 >> PSL-42004 CONTROL 2 #14 >> PSH-42005 CONTROL	 C-420-043 C-420-060
C-420-050	420E104	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PSH-42002 TO: CONDUIT TEE 2 #14 >> PSH-42002 CONTROL	C-420-051
C-420-051	420E104 420E106	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: VFD-42002 2 #14 >> PSL-42001 CONTROL 2 #14 >> PSH-42002 CONTROL	 C-420-040 C-420-050
C-420-055	420E104	0.75"	2 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: P-42001 TO: VFD-42001 2 #14 >> TSH-42001 2 #12 >> MWH-42001	
C-420-056	420E104	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-42001 TO: VFD-42001 12 #14 >> LCP-42001 CONTROL	
C-420-057	420E106	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-42001 TO: LCP-42020 12 #14 >> VFD-42001 CONTROL	C-420-070
C-420-060	420E104	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PSH-42005 TO: CONDUIT TEE 2 #14 >> PSH-42005 CONTROL	C-420-044
C-420-065	420E104	0.75"	2 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: P-42002 TO: VFD-42002 2 #14 >> TSH-42002 2 #12 >> MWH-42002	
C-420-066	420E104	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-42002 TO: VFD-42002 12 #14 >> LCP-42002 CONTROL	
C-420-067	420E106	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-42002 TO: LCP-42020 12 #14 >> VFD-42002 CONTROL	C-420-070
C-420-070	420E106	1.5"	24	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: LCP-42020 12 #14 >> VFD-42002 CONTROL 12 #14 >> VFD-42001 CONTROL	 C-420-067 C-420-057

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SLUDGE STORAGE BUILDING

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-420-080	420E104	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE/LSL-42010 TO: VCP-42010 1 MFR >> LE/LSL-42010 CONTROL	
C-420-081	420E104	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE/LS1-42010 TO: VCP-42010 1 MFR >> LE/LS1-42010 CONTROL	
C-420-082	420E104	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE/LSH-42010 TO: VCP-42010 1 MFR >> LE/LSH-42010 CONTROL	
C-420-085	420E104 420E106	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-42010 TO: LCP-42020 10 #14 >> VCP-42010 CONTROL	
C-420-090	420E104 420E106	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-42001 TO: JUNCTION BOX 2 #14 >> SF-42032 RUNNING STATUS 2 #14 >> EF-42033 RUNNING STATUS	C-420-110
C-420-091	420E104 420E106	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-42021 TO: JUNCTION BOX 4 #14 >> LCP-42021 CONTROL	C-420-110
C-420-095	420E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: XB31-42021 TO: CONDUIT TEE 2 #14 >> XB31-42021 CONTROL	C-420-097
C-420-096	420E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: XB32-42021 TO: CONDUIT TEE 2 #14 >> XB32-42021 CONTROL	C-420-097
C-420-097	420E102	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: LCP-42021 2 #14 >> XB31-42021 CONTROL 2 #14 >> XB32-42021 CONTROL	C-420-095 C-420-096
C-420-100	420E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: XB41-42021 TO: CONDUIT TEE 2 #14 >> XB41-42021 CONTROL	C-420-102
C-420-101	420E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: XB42-42021 TO: CONDUIT TEE 2 #14 >> XB42-42021 CONTROL	C-420-102
C-420-102	420E102	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: JUNCTION BOX 2 #14 >> XB41-42021 CONTROL 2 #14 >> XB42-42021 CONTROL	C-420-110 C-420-100 C-420-101
C-420-105	420E104	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: XB21-42021 TO: CONDUIT TEE 2 #14 >> XB21-42021 CONTROL	C-420-107
C-420-106	420E104	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: XB22-42021 TO: CONDUIT TEE 2 #14 >> XB22-42021 CONTROL	C-420-107
C-420-107	420E104	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: JUNCTION BOX 2 #14 >> XB21-42021 CONTROL 2 #14 >> XB22-42021 CONTROL	C-420-110 C-420-105 C-420-106
C-420-110	420E102	1.5"	2 16	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: LCP-42021 TO: JUNCTION BOX 2 #12 >> LCP-42021 POWER 4 #14 >> LCP-42021 CONTROL 2 #14 >> XB21-42021 CONTROL 2 #14 >> XB22-42021 CONTROL 2 #14 >> SF-42032 RUNNING STATUS 2 #14 >> EF-42033 RUNNING STATUS 2 #14 >> XB41-42021 CONTROL 2 #14 >> XB42-42021 CONTROL	L-420-091 C-420-091 C-420-107 C-420-107 C-420-090 C-420-090 C-420-102 C-420-102
C-420-310	420E106	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AHU-42030 TO: TSHL-42030 2 #14 >> AHU-42030 CONTROL	
C-420-313	420E106	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AHU-42031 TO: TSHL-42031 2 #14 >> AHU-42031 CONTROL	

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SLUDGE STORAGE BUILDING

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
L-420-001	420E106	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: LCP-42020 TO: LP-42001 2 #10 >> LCP-42020 POWER	
L-420-005	420E106	2"	4	#1/0	XHHW-2	1	#6	XHHW-2	FR: LP-42001 TO: XF-42001 4 #1/0 >> LP-42001 POWER	
L-420-020	420E106	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FACP-42001 TO: LP-42001 2 #12 >> FACP-42001 POWER	
L-420-030	420E104	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-42003 TO: LCP-42020 2 #12 >> FIT-42003 POWER	
L-420-091	420E104 420E106	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: LCP-42021 TO: JUNCTION BOX 2 #12 >> LCP-42021 POWER	C-420-110
L-420-310	420E102	0.75"	2	#8	XHHW-2	1	#10	XHHW-2	FR: CDU-42030 TO: DISC-42030 2 #8 >> CDU-42030 POWER	
L-420-311	420E102	0.75"	2	#8	XHHW-2	1	#10	XHHW-2	FR: DISC-42030 TO: CONDUIT TEE 2 #8 >> DISC-42030 POWER	L-420-315
L-420-313	420E102	0.75"	2	#8	XHHW-2	1	#10	XHHW-2	FR: CDU-42031 TO: DISC-42031 2 #8 >> CDU-42031 POWER	
L-420-314	420E102	0.75"	2	#8	XHHW-2	1	#10	XHHW-2	FR: DISC-42031 TO: CONDUIT TEE 2 #8 >> DISC-42031 POWER	L-420-315
L-420-315	420E102	1"	4	#8	XHHW-2	1	#10	XHHW-2	FR: CONDUIT TEE TO: LP-42001 2 #8 >> DISC-42030 POWER 2 #8 >> DISC-42031 POWER	L-420-311 L-420-314
N-420-001	420E104	2"	1		12/FO	1	#14	XHHW-2	FR: LCP-42020 TO: 320 COMPUTER NETWORK CABINET 1 12/FO >> LCP-42020 NETWORK	
N-420-003	420E106	1"	1		CAT6	1	#14	XHHW-2	FR: PQM-42001 TO: LCP-42020 1 CAT6 >> PQM-42001 NETWORK	
P-420-001	420E106	2"	3	#3/0	XHHW-2	1	#2	XHHW-2	FR: MCC-42001 TO: ATS-42001 3 #3/0 >> MCC-42001 POWER	
P-420-002	420E106	2"	3	#3/0	XHHW-2	1	#2	XHHW-2	FR: MCC-42001 TO: ATS-42001 3 #3/0 >> MCC-42001 POWER	
P-420-005	420E106	1.5"	3	#1	XHHW-2	1	#6	XHHW-2	FR: XF-42001 TO: MCC-42001 3 #1 >> XF-42001 POWER	
P-420-010	420E106	1.5"	3	#1/0	XHHW-2	1	#6	XHHW-2	FR: PP-42001 TO: MCC-42001 3 #1/0 >> PP-42001 POWER	
P-420-020	420E104	3"	3	#3/0	XHHW-2	1	#2	XHHW-2	FR: ATS-42001 TO: SG-3201A 3 #3/0 >> ATS-42001 POWER	
P-420-021	420E104	3"	3	#3/0	XHHW-2	1	#2	XHHW-2	FR: ATS-42001 TO: SG-3201A 3 #3/0 >> ATS-42001 POWER	
P-420-025	420E104	3"	3	#3/0	XHHW-2	1	#2	XHHW-2	FR: ATS-42001 TO: SG-3201B 3 #3/0 >> ATS-42001 POWER	
P-420-026	420E104	3"	3	#3/0	XHHW-2	1	#2	XHHW-2	FR: ATS-42001 TO: SG-3201B 3 #3/0 >> ATS-42001 POWER	

CONDUIT SCHEDULE AREA

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
P-420-050	420E106	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: VFD-42001 TO: MCC-42001 3 #6 >> VFD-42001 POWER	
P-420-055	420E106	1.5"	1	3/C-#8:VFD	VFD			INTEGRAL	FR: P-42001 TO: VFD-42001 1 3/C-#8:VFD >> P-42001 POWER	
P-420-060	420E106	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: VFD-42002 TO: MCC-42001 3 #6 >> VFD-42002 POWER	
P-420-065	420E106	1.5"	1	3/C-#8:VFD	VFD			INTEGRAL	FR: P-42002 TO: VFD-42002 1 3/C-#8:VFD >> P-42002 POWER	
P-420-080	420E104	1"	1	MFR	CABLE	1	#14	XHHW-2	FR: P-42010 TO: VCP-42010 1 MFR >> P-42010 POWER	
P-420-081	420E104	1"	1	MFR	CABLE	1	#14	XHHW-2	FR: P-42011 TO: VCP-42010 1 MFR >> P-42011 POWER	
P-420-085	420E104 420E106	0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: VCP-42010 TO: PP-42001 3 #10 >> VCP-42010 POWER	
P-420-100	420E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: STORAGE ROOM MONORAIL TO: MONORAIL DISCONNECT 3 #12 >> STORAGE ROOM MONORAIL POWER	
P-420-101	420E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MONORAIL DISCONNECT TO: PP-42001 3 #12 >> MONORAIL DISCONNECT POWER	
P-420-300	420E104	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EUH-42015 TO: DISC-42015 3 #12 >> EUH-42015 POWER	
P-420-301	420E104	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-42015 TO: PP-42001 3 #12 >> EUH-42015 POWER	
P-420-320	420E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EF-42032 TO: DISC-42032 3 #12 >> EF-42032 POWER	
P-420-321	420E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-42032 TO: MCC-42001 3 #12 >> EF-42032 POWER	
P-420-325	420E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: SF-42033 TO: DISC-42033 3 #12 >> SF-42033 POWER	
P-420-326	420E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-42033 TO: MCC-42001 3 #12 >> DISC-42033 POWER	
S-420-030	420E104	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-42003 TO: FIT-42003 1 MFR >> FE-42003	
S-420-031	420E104	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FIT-42003 TO: LCP-42020 1 MFR >> FIT-42003 SIGNAL	
S-420-033	420E106	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TIT-42033 TO: LCP-42020 1 2/CS-#16 >> TIT-42033 SIGNAL	
S-420-051	420E104	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-42002 TO: CONDUIT TEE 1 2/CS-#16 >> PIT-42002 SIGNAL	S-420-054
S-420-053	420E104	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-42005 TO: CONDUIT TEE 1 2/CS-#16 >> PIT-42005 SIGNAL	S-420-054

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
S-420-054	420E104 420E106	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: LCP-42020 1 2/CS-#16 >> PIT-42002 SIGNAL 1 2/CS-#16 >> PIT-42005 SIGNAL	 S-420-051 S-420-053
S-420-056	420E104	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LCP-42001 TO: VFD-42001 1 2/CS-#16 >> LCP-42001	
S-420-057	420E106	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VFD-42001 TO: LCP-42020 2 2/CS-#16 >> VFD-42001 SIGNAL	S-420-070
S-420-066	420E104	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LCP-42004 TO: VFD-42002 1 2/CS-#16 >> LCP-42004 SIGNAL	
S-420-067	420E106	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VFD-42002 TO: LCP-42020 2 2/CS-#16 >> VFD-42002 SIGNAL	S-420-070
S-420-070	420E106	1"	4	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: LCP-42020 2 2/CS-#16 >> VFD-42002 SIGNAL 2 2/CS-#16 >> VFD-42001 SIGNAL	 S-420-067 S-420-057
X-420-020	420E104	2"	1	PULL	ROPE				FR: CAPPED IN 420 PUMP ROOM TO: CAPPED AT 320 1 PULL >> SPARE	
X-420-021	420E104	2"	1	PULL	ROPE				FR: CAPPED IN 420 PUMP ROOM TO: CAPPED AT 320 1 PULL >> SPARE	
X-420-022	420E104	2"	1	PULL	ROPE				FR: CAPPED IN 420 PUMP ROOM TO: CAPPED AT 320 1 PULL >> SPARE	
		0.75"				1	#14	XHHW-2	FR: TO:	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 26_06_03

CONDUIT SCHEDULE
AREA 440

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 26_05_00 and Section 26_05_33.

B. Cable requirements and definitions:
   1. As defined in Section 26_05_00 and Section 26_05_18.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. PULL: Pull Rope.
   5. VFD: Shielded VFD cable with integral ground.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SLUDGE STORAGE TANKS

ENGINEER	TDT
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-440-021	440E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-44001	C-440-025
									TO: CONDUIT TEE	
									10 #14 >> LCP-44001 CONTROL	
C-440-022	440E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-44002	C-440-025
									TO: CONDUIT TEE	
									10 #14 >> LCP-44002 CONTROL	
C-440-025	440E102	1.5"	20	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-440-050
									TO: CONDUIT TEE	
									10 #14 >> LCP-44001 CONTROL	C-440-021
									10 #14 >> LCP-44002 CONTROL	C-440-022
C-440-030	440E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: HTC-44004	C-440-050
									TO: SLUDGE TANK CONTROL J-BOX	
									2 #14 >> HTC-44004 CONTROL	
C-440-050	440E102	2"	26	#14	XHHW-2	1	#14	XHHW-2	FR: SLUDGE TANK CONTROL J-BOX	C-440-060
									TO: CONDUIT TEE	
									10 #14 >> LCP-44001 CONTROL	C-440-025
									10 #14 >> LCP-44002 CONTROL	C-440-025
									2 #14 >> HTC-44004 CONTROL	C-440-030
									2 #14 >> SV-44001 CONTROL	C-440-055
									2 #14 >> SV-44002 CONTROL	C-440-055
C-440-051	440E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SV-44001	C-440-055
									TO: CONDUIT TEE	
									2 #14 >> SV-44001 CONTROL	
C-440-053	440E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SV-44002	C-440-055
									TO: CONDUIT TEE	
									2 #14 >> SV-44002 CONTROL	
C-440-055	440E102	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-440-050
									TO: CONDUIT TEE	
									2 #14 >> SV-44001 CONTROL	C-440-051
									2 #14 >> SV-44002 CONTROL	C-440-053
C-440-060	440E102	2"	4	#12	XHHW-2	1	#12	XHHW-2	FR: SLUDGE TANK CONTROL J-BOX	
			28	#14	XHHW-2				TO: CONDUIT TEE	
									10 #14 >> LCP-44001 CONTROL	C-440-050
									10 #14 >> LCP-44002 CONTROL	C-440-050
									2 #14 >> SV-44001 CONTROL	C-440-050
									2 #14 >> SV-44002 CONTROL	C-440-050
									2 #12 >> MIX-44001 MWH	C-440-061
									2 #14 >> MIX-44001 TSH	C-440-061
									2 #12 >> MIX-44005 MWH	C-440-071
									2 #14 >> MIX-44005 TSH	C-440-071
C-440-061	440E102	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	C-440-060
			2	#14	XHHW-2				TO: SLUDGE TANK CONTROL J-BOX	
									2 #12 >> MIX-44001 MWH	
									2 #14 >> MIX-44001 TSH	
C-440-071	440E102	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	C-440-060
			2	#14	XHHW-2				TO: SLUDGE TANK CONTROL J-BOX	
									2 #12 >> MIX-44005 MWH	
									2 #14 >> MIX-44005 TSH	
C-440-300	440E102	2"	14	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-44020	
									TO: MCC-42001	
									10 #14 >> VCP-44020 CONTROL	
									4 #14 >> SPARES	
L-440-030	440E102	1"	3	#8	XHHW-2	1	#10	XHHW-2	FR: HTC-44004	L-440-060
									TO: SLUDGE TANK POWER J-BOX	
									3 #8 >> HTC-44004 POWER	
L-440-050	440E102	2"	4	#10	XHHW-2	1	#10	XHHW-2	FR: SLUDGE TANK POWER J-BOX	L-440-060
									TO: CONDUIT TEE	
									2 #10 >> SLUDGE TANK LIGHTING	
									2 #10 >> SLUDGE TANK RECEPTACLES	
L-440-060	440E102	2"	3	#8	XHHW-2	1	#10	XHHW-2	FR: SLUDGE TANK POWER J-BOX	
			4	#10	XHHW-2				TO: LP-42001	
									3 #8 >> HTC-44004 POWER	L-440-030
									2 #10 >> SLUDGE TANK LIGHTING	L-440-050
									2 #10 >> SLUDGE TANK RECEPTACLES	L-440-050
P-440-060	440E102	1.5"	1	3/C-#10:VFD	VFD			INTEGRAL	FR: MIX-44001	
			2	#12	XHHW-2				TO: CONDUIT TEE	
			2	#14	XHHW-2				1 3/C-#10:VFD >> MIX-44001 POWER	
									2 #12 >> MIX-44001 MWH	
									2 #14 >> MIX-44001 TSH	

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SLUDGE STORAGE TANKS

ENGINEER TDT

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
P-440-061	440E102	1.5"	1	3/C-#10:VFD	VFD			INTEGRAL	FR: CONDUIT TEE	P-440-065
									TO: SLUDGE TANK POWER J-BOX	
									1 3/C-#10:VFD >> MIX-44001 POWER	
P-440-065	440E102	2"	1	3/C-#10:VFD	VFD			INTEGRAL	FR: SLUDGE TANK POWER J-BOX	
									TO: MCC-42001	
									1 3/C-#10:VFD >> MIX-44001 POWER	P-440-061
P-440-070	440E102	1.5"	1	3/C-#10:VFD	VFD			INTEGRAL	FR: MIX-44005	
			2	#12	XHHW-2				TO: CONDUIT TEE	
			2	#14	XHHW-2				1 3/C-#10:VFD >> MIX-44005 POWER	
									2 #12 >> MIX-44005 MWH	
									2 #14 >> MIX-44005 TSH	
P-440-071	440E102	1.5"	1	3/C-#10:VFD	VFD			INTEGRAL	FR: CONDUIT TEE	P-440-075
									TO: SLUDGE TANK POWER J-BOX	
									1 3/C-#10:VFD >> MIX-44005 POWER	
P-440-075	440E102	2"	1	3/C-#10:VFD	VFD			INTEGRAL	FR: SLUDGE TANK POWER J-BOX	
									TO: MCC-42001	
									1 3/C-#10:VFD >> MIX-44005 POWER	P-440-071
P-440-300	440E102	2"	3	#6	XHHW-2	1	#10	XHHW-2	FR: VCP-44020	
									TO: MCC-42001	
									3 #6 >> VCP-44020 POWER	
S-440-021	440E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LCP-44001	S-440-025
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LCP-44001 SIGNAL	
S-440-022	440E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LCP-44002	S-440-025
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LCP-44002 SIGNAL	
S-440-025	440E102	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-440-045
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LCP-44001 SIGNAL	S-440-021
									1 2/CS-#16 >> LCP-44002 SIGNAL	S-440-022
S-440-031	440E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-44001	S-440-035
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LIT-44001 SIGNAL	
S-440-032	440E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-44002	S-440-035
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LIT-44002 SIGNAL	
S-440-035	440E102	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-440-038
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LIT-44001 SIGNAL	S-440-031
									1 2/CS-#16 >> LIT-44002 SIGNAL	S-440-032
S-440-038	440E102	1"	3	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-440-050
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LIT-44001 SIGNAL	S-440-035
									1 2/CS-#16 >> LIT-44002 SIGNAL	S-440-035
									1 2/CS-#16 >> LIT-44003 SIGNAL	S-440-043
S-440-043	440E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-44003	S-440-038
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LIT-44003 SIGNAL	
S-440-044	440E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-44004	S-440-045
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LIT-44004 SIGNAL	
S-440-045	440E102	1"	3	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-440-050
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LCP-44001 SIGNAL	S-440-025
									1 2/CS-#16 >> LCP-44002 SIGNAL	S-440-025
									1 2/CS-#16 >> LIT-44004 SIGNAL	S-440-044
S-440-050	440E102	2"	6	2/CS-#16		1	#14	XHHW-2	FR: SLUDGE TANK SIGNAL J-BOX	S-440-060
									TO: CONDUIT TEE	
									1 2/CS-#16 >> LIT-44001 SIGNAL	S-440-038
									1 2/CS-#16 >> LIT-44002 SIGNAL	S-440-038
									1 2/CS-#16 >> LIT-44003 SIGNAL	S-440-038
									1 2/CS-#16 >> LCP-44001 SIGNAL	S-440-045
									1 2/CS-#16 >> LCP-44002 SIGNAL	S-440-045
									1 2/CS-#16 >> LIT-44004 SIGNAL	S-440-045

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SLUDGE STORAGE TANKS

ENGINEER TDT

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CONDUIT			CONDUCTORS			GROUND								
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION					CONNECTING SEGMENTS
S-440-060	440E102	2"	6	2/CS-#16		1	#14	XHHW-2	FR:			CONDUIT TEE		
									TO:			SLUDGE TANK SIGNAL J-BOX		
										1	2/CS-#16	>> LIT-44001 SIGNAL		S-440-050
										1	2/CS-#16	>> LIT-44002 SIGNAL		S-440-050
										1	2/CS-#16	>> LIT-44003 SIGNAL		S-440-050
										1	2/CS-#16	>> LCP-44001 SIGNAL		S-440-050
										1	2/CS-#16	>> LCP-44002 SIGNAL		S-440-050
										1	2/CS-#16	>> LIT-44004 SIGNAL		S-440-050
X-440-060	440E102	2"	1	PULL	ROPE				FR:			CAPPED IN 420 PUMP ROOM		
									TO:			SLUDGE TANK SIGNAL J-BOX		
										1	PULL	>> SPARE		
X-440-061	440E102	2"	1	PULL	ROPE				FR:			CAPPED IN 420 PUMP ROOM		
									TO:			SLUDGE TANK CONTROL J-BOX		
										1	PULL	>> SPARE		
X-440-063	440E102	2"	1	PULL	ROPE				FR:			CAPPED IN 420 PUMP ROOM		
									TO:			SLUDGE TANK POWER J-BOX		
										1	PULL	>> SPARE		
X-440-300	440E102	2"	1	PULL	ROPE				FR:			VCP-44020		
									TO:			CAPPED IN 420 PUMP ROOM		
										1	PULL	>> SPARE		

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 26_06_04

CONDUIT SCHEDULE
AREA 530

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 26_05_00 and Section 26_05_33.

B. Cable requirements and definitions:
   1. As defined in Section 26_05_00 and Section 26_05_18.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. 3/CS#16: 3 conductor, 16 gauge, twisted shielded triplet.
   4. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   5. MFR: Manufacturer or vendor furnished cable.
   6. PULL: Pull Rope.
   7. VFD: Shielded VFD cable with integral ground.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SOLIDS HANDLING BUILDING EAST

ENGINEER TDT

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-530-022	530E101	1"	2 1	#12 3/CS-#16	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: MIX-53012 LCP 1 3/CS-#16 >> MIX-53012 RTD 2 #12 >> MIX-53012 MWH	
C-530-025	530E101	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-53012 LCP TO: CONDUIT TEE 8 #14 >> MIX-53012 LCP CONTROL	C-530-035
C-530-028	530E101	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-53061 TO: CONDUIT TEE 12 #14 >> VFD-53061 CONTROL	C-530-037
C-530-030	530E101	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-53062 TO: CONDUIT TEE 12 #14 >> VFD-53062 CONTROL	C-530-040
C-530-035	530E101	2"	4 64	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 8 #14 >> MIX-53012 LCP CONTROL 2 #12 >> AIT-53011 POWER 2 #12 >> FIT-53011 POWER 2 #14 >> SV-53011 CONTROL 2 #14 >> SV-53001 CONTROL 2 #14 >> SV-53002 CONTROL 10 #14 >> EDR-53010 CONTROL 10 #14 >> EDR-53016 CONTROL 10 #14 >> EDR-53014 CONTROL 10 #14 >> EDR-53015 CONTROL 10 #14 >> VCP-53020 CONTROL	C-530-037 C-530-025 C-530-110 C-530-110 C-530-110 C-530-110 C-530-110 C-530-110 C-530-110 C-530-110 C-530-110 C-530-110
C-530-037	530E101	2"	4 76	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 12 #14 >> VFD-53061 CONTROL 8 #14 >> MIX-53012 LCP CONTROL 2 #12 >> AIT-53011 POWER 2 #12 >> FIT-53011 POWER 2 #14 >> SV-53011 CONTROL 2 #14 >> SV-53001 CONTROL 2 #14 >> SV-53002 CONTROL 10 #14 >> EDR-53010 CONTROL 10 #14 >> EDR-53016 CONTROL 10 #14 >> EDR-53014 CONTROL 10 #14 >> EDR-53015 CONTROL 10 #14 >> VCP-53020 CONTROL	C-530-040 C-530-028 C-530-035 C-530-035 C-530-035 C-530-035 C-530-035 C-530-035 C-530-035 C-530-035 C-530-035 C-530-035 C-530-035
C-530-040	530E101	2.5"	4 88	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: LCP-53020 12 #14 >> VFD-53062 CONTROL 12 #14 >> VFD-53061 CONTROL 8 #14 >> MIX-53012 LCP CONTROL 2 #12 >> AIT-53011 POWER 2 #12 >> FIT-53011 POWER 2 #14 >> SV-53011 CONTROL 2 #14 >> SV-53001 CONTROL 2 #14 >> SV-53002 CONTROL 10 #14 >> EDR-53010 CONTROL 10 #14 >> EDR-53016 CONTROL 10 #14 >> EDR-53014 CONTROL 10 #14 >> EDR-53015 CONTROL 10 #14 >> VCP-53020 CONTROL	 C-530-030 C-530-037 C-530-037 C-530-037 C-530-037 C-530-037 C-530-037 C-530-037 C-530-037 C-530-037 C-530-037 C-530-037 C-530-037
C-530-050	530E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-53061 TO: CONDUIT TEE 10 #14 >> LCP-53061 CONTROL	C-530-052
C-530-051	530E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PSH-53061 TO: CONDUIT TEE 2 #14 >> PSH-53061 CONTROL	C-530-052
C-530-052	530E102	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: VFD-53061 10 #14 >> LCP-53061 CONTROL 2 #14 >> PSH-53061 CONTROL	 C-530-050 C-530-051
C-530-060	530E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-53062 TO: CONDUIT TEE 10 #14 >> LCP-53062 CONTROL	C-530-063
C-530-062	530E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PSH-53062 TO: CONDUIT TEE 2 #14 >> PSH-53062 CONTROL	C-530-063

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SOLIDS HANDLING BUILDING EAST

ENGINEER TDT

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-530-063	530E102	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	
									TO: VFD-53062	
									10 #14 >> LCP-53062 CONTROL	C-530-060
									2 #14 >> PSH-53062 CONTROL	C-530-062
C-530-070	530E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: EDR-53010	C-530-072
									TO: CONDUIT TEE	
									10 #14 >> EDR-53010 CONTROL	
C-530-072	530E102	1.5"	20	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-530-080
									TO: CONDUIT TEE	
									10 #14 >> EDR-53010 CONTROL	C-530-070
									10 #14 >> EDR-53016 CONTROL	C-530-076
C-530-074	530E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: EDR-53014	C-530-077
									TO: CONDUIT TEE	
									10 #14 >> EDR-53014 CONTROL	
C-530-075	530E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: EDR-53015	C-530-077
									TO: CONDUIT TEE	
									10 #14 >> EDR-53015 CONTROL	
C-530-076	530E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: EDR-53016	C-530-072
									TO: CONDUIT TEE	
									10 #14 >> EDR-53016 CONTROL	
C-530-077	530E102	1.5"	20	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-530-080
									TO: CONDUIT TEE	
									10 #14 >> EDR-53014 CONTROL	C-530-074
									10 #14 >> EDR-53015 CONTROL	C-530-075
C-530-080	530E102	1.5"	40	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-530-081
									TO: CONDUIT TEE	
									10 #14 >> EDR-53010 CONTROL	C-530-072
									10 #14 >> EDR-53016 CONTROL	C-530-072
									10 #14 >> EDR-53014 CONTROL	C-530-077
									10 #14 >> EDR-53015 CONTROL	C-530-077
C-530-081	530E102	2"	50	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-530-110
									TO: CONTROL JUNCTION BOX	
									10 #14 >> EDR-53010 CONTROL	C-530-080
									10 #14 >> EDR-53016 CONTROL	C-530-080
									10 #14 >> EDR-53014 CONTROL	C-530-080
									10 #14 >> EDR-53015 CONTROL	C-530-080
									10 #14 >> VCP-53020 CONTROL	C-530-101
C-530-090	530E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SV-53011	C-530-096
									TO: CONDUIT TEE	
									2 #14 >> SV-53011 CONTROL	
C-530-091	530E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SV-53001	C-530-095
									TO: CONDUIT TEE	
									2 #14 >> SV-53001 CONTROL	
C-530-092	530E102	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SV-53002	C-530-095
									TO: CONDUIT TEE	
									2 #14 >> SV-53002 CONTROL	
C-530-095	530E102	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-530-096
									TO: CONDUIT TEE	
									2 #14 >> SV-53001 CONTROL	C-530-091
									2 #14 >> SV-53002 CONTROL	C-530-092
C-530-096	530E102	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-530-110
									TO: CONTROL JUNCTION BOX	
									2 #14 >> SV-53011 CONTROL	C-530-090
									2 #14 >> SV-53001 CONTROL	C-530-095
									2 #14 >> SV-53002 CONTROL	C-530-095
C-530-100	530E102	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: SUMP PUMP TERMINATION BOX	
									TO: VCP-53020	
									2 #14 >> LSL-53020	
									2 #14 >> LS1-53020	
									2 #14 >> LSH-53020	
C-530-101	530E102	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-53020	C-530-081
									TO: CONDUIT TEE	
									10 #14 >> VCP-53020 CONTROL	

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SOLIDS HANDLING BUILDING EAST

ENGINEER	TDT
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-530-110	530E102	2"	4	#12	XHHW-2	1	#12	XHHW-2	FR: CONTROL JUNCTION BOX	C-530-035
			56	#14	XHHW-2				TO: LCP-53020	
									2 #12 >> AIT-53011 POWER	L-530-015
									2 #12 >> FIT-53011 POWER	L-530-015
									2 #14 >> SV-53011 CONTROL	C-530-096
									2 #14 >> SV-53001 CONTROL	C-530-096
									2 #14 >> SV-53002 CONTROL	C-530-096
									10 #14 >> EDR-53010 CONTROL	C-530-081
									10 #14 >> EDR-53016 CONTROL	C-530-081
									10 #14 >> EDR-53014 CONTROL	C-530-081
									10 #14 >> EDR-53015 CONTROL	C-530-081
									10 #14 >> VCP-53020 CONTROL	C-530-081
L-530-012	530E102	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-53011	L-530-015
									TO: CONDUIT TEE	
									2 #12 >> AIT-53011 POWER	
L-530-014	530E102	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-53011	L-530-015
									TO: CONDUIT TEE	
									2 #12 >> FIT-53011 POWER	
L-530-015	530E102	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	C-530-110
									TO: CONTROL JUNCTION BOX	
									2 #12 >> AIT-53011 POWER	L-530-012
									2 #12 >> FIT-53011 POWER	L-530-014
P-530-005	530E101	3"	3	350	XHHW-2	1	#1	XHHW-2	FR: PP-53002	
									TO: SG-5301A	
									3 350 >> PP-53002 POWER	
P-530-006	530E101	3"	3	350	XHHW-2	1	#1	XHHW-2	FR: PP-53002	
									TO: SG-5301A	
									3 350 >> PP-53002 POWER	
P-530-020	530E101	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-53012 LCP	
									TO: PP-53002	
									3 #12 >> MIX-53012 LCP POWER	
P-530-021	530E101	1"	5	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-53012	
			1	3/CS-#16					TO: CONDUIT TEE	
									3 #12 >> MIX-53012 POWER	
									1 3/CS-#16 >> MIX-53012 RTD	
									2 #12 >> MIX-53012 MWH	
P-530-022	530E101	1"	3	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	
									TO: MIX-53012 LCP	
									3 #12 >> MIX-53012 POWER	
P-530-050	530E101	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: VFD-53061	
									TO: PP-53002	
									3 #6 >> VFD-53061 POWER	
P-530-051	530E101	1.5"	1	3/C-#8:VFD	VFD			INTEGRAL	FR: P-53061	
			2	#12	XHHW-2				TO: VFD-53061	
			2	#14	XHHW-2				1 3/C-#8:VFD >> P-53061 POWER	
									2 #12 >> MWH-53061 POWER	
									2 #14 >> TSH-53061 POWER	
P-530-060	530E101	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: VFD-53062	
									TO: PP-53002	
									3 #6 >> VFD-53062 POWER	
P-530-061	530E101	1.5"	1	3/C-#8:VFD	VFD			INTEGRAL	FR: P-53062	
			2	#12	XHHW-2				TO: VFD-53062	
			2	#14	XHHW-2				1 3/C-#8:VFD >> P-53062 POWER	
									2 #12 >> MWH-53062 POWER	
									2 #14 >> TSH-53062 POWER	
P-530-070	530E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDR-53010	P-530-077
									TO: CONDUIT TEE	
									3 #12 >> EDR-53010 POWER	
P-530-074	530E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDR-53014	P-530-078
									TO: CONDUIT TEE	
									3 #12 >> EDR-53014 POWER	
P-530-075	530E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDR-53015	P-530-078
									TO: CONDUIT TEE	
									3 #12 >> EDR-53015 POWER	
P-530-076	530E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDR-53016	P-530-077
									TO: CONDUIT TEE	
									3 #12 >> EDR-53016 POWER	

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SOLIDS HANDLING BUILDING EAST

ENGINEER TDT

REVISION

DATE 8/30/24

CONDUIT			CONDUCTORS			GROUND							
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE			DESCRIPTION		CONNECTING SEGMENTS
P-530-077	530E101 530E102	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: TO: 3 3	 #12 #12	CONDUIT TEE PP-53002 >> EDR-53010 POWER >> EDR-53016 POWER		 P-530-070 P-530-076
P-530-078	530E102	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: TO: 3 3	 #12 #12	CONDUIT TEE PP-53002 >> EDR-53014 POWER >> EDR-53015 POWER		 P-530-074 P-530-075
P-530-080	530E102	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: TO: 3	 #12	WATER HEATER PP-53002 >> WATER HEATER POWER		
P-530-100	530E102	1"	6	#10	XHHW-2	1	#10	XHHW-2	FR: TO: 3 3	 #10 #10	SUMP PUMP TERMINATION BOX VCP-53020 >> P-53020 POWER >> P-53021 POWER		
P-530-102	530E102	0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: TO: 3	 #10	VCP-53020 PP-53002 >> VCP-53020 POWER		
S-530-011	530E102	1"	1	MFR	CABLE	1	#14	XHHW-2	FR: TO: 1	 MFR	AE-53011 AIT-53011 >> AE-53011 SIGNAL		
S-530-012	530E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TO: 1	 2/CS-#16	AIT-53011 CONDUIT TEE >> AIT-53011 SIGNAL		S-530-015
S-530-013	530E102	1"	1	MFR	CABLE	1	#14	XHHW-2	FR: TO: 1	 MFR	FE-53013 FIT-53013 >> FE-53013 SIGNAL		
S-530-014	530E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TO: 1	 2/CS-#16	FIT-53013 CONDUIT TEE >> FIT-53013 SIGNAL		S-530-015
S-530-015	530E102	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: TO: 1 1	 2/CS-#16 2/CS-#16	CONDUIT TEE SIGNAL JUNCTION BOX >> AIT-53011 SIGNAL >> FIT-53013 SIGNAL		S-530-105 S-530-012 S-530-014
S-530-025	530E101	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: TO: 2	 2/CS-#16	MIX-53012 LCP CONDUIT TEE >> MIX-53012 LCP SIGNAL		S-530-035
S-530-028	530E101	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: TO: 2	 2/CS-#16	VFD-53061 CONDUIT TEE >> VFD-53061 SIGNAL		S-530-037
S-530-030	530E101	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: TO: 2	 2/CS-#16	VFD-53062 CONDUIT TEE >> VFD-53062 SIGNAL		S-530-040
S-530-035	530E101	1.5"	6	2/CS-#16		1	#14	XHHW-2	FR: TO: 2 1 1 1 1	 2/CS-#16 2/CS-#16 2/CS-#16 2/CS-#16 2/CS-#16	CONDUIT TEE CONDUIT TEE >> MIX-53012 LCP SIGNAL >> AIT-53011 SIGNAL >> FIT-53013 SIGNAL >> PIT-53062 SIGNAL >> PIT-53062 SIGNAL		S-530-037 S-530-025 S-530-105 S-530-105 S-530-105 S-530-105
S-530-037	530E101	1.5"	8	2/CS-#16		1	#14	XHHW-2	FR: TO: 2 2 1 1 1 1	 2/CS-#16 2/CS-#16 2/CS-#16 2/CS-#16 2/CS-#16 2/CS-#16	CONDUIT TEE CONDUIT TEE >> VFD-53061 SIGNAL >> MIX-53012 LCP SIGNAL >> AIT-53011 SIGNAL >> FIT-53013 SIGNAL >> PIT-53062 SIGNAL >> PIT-53062 SIGNAL		S-530-040 S-530-028 S-530-035 S-530-035 S-530-035 S-530-035 S-530-035
S-530-040		2"	10	2/CS-#16		1	#14	XHHW-2	FR: TO: 2 2 2 1 1 1 1	 2/CS-#16 2/CS-#16 2/CS-#16 2/CS-#16 2/CS-#16 2/CS-#16 2/CS-#16	CONDUIT TEE LCP-53020 >> VFD-53062 SIGNAL >> VFD-53061 SIGNAL >> MIX-53012 LCP SIGNAL >> AIT-53011 SIGNAL >> FIT-53013 SIGNAL >> PIT-53062 SIGNAL >> PIT-53062 SIGNAL		 S-530-030 S-530-037 S-530-037 S-530-037 S-530-037 S-530-037 S-530-037

CONDUIT SCHEDULE AREA

PRIMARY SLUDGE TANK REPLACEMENT PROJECT

SOLIDS HANDLING BUILDING EAST

ENGINEER TDT

REVISION

DATE 8/30/24

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
S-530-050	530E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LCP-53061 TO: CONDUIT TEE 1 2/CS-#16 >> LCP-53061 SIGNAL	S-530-065
S-530-051	530E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: VFD-53061 1 2/CS-#16 >> LCP-53061 SIGNAL	
S-530-052	530E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-53061 TO: CONDUIT TEE 1 2/CS-#16 >> PIT-53062 SIGNAL	S-530-055
S-530-055	530E102	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: SIGNAL JUNCTION BOX 1 2/CS-#16 >> PIT-53062 SIGNAL 1 2/CS-#16 >> PIT-53062 SIGNAL	S-530-105 S-530-052 S-530-062
S-530-060	530E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LCP-53062 TO: CONDUIT TEE 1 2/CS-#16 >> LCP-53062 SIGNAL	S-530-065
S-530-061	530E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: VFD-53062 1 2/CS-#16 >> LCP-53062 SIGNAL	
S-530-062	530E102	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-53062 TO: CONDUIT TEE 1 2/CS-#16 >> PIT-53062 SIGNAL	S-530-055
S-530-065	530E102	2"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 1 2/CS-#16 >> LCP-53061 SIGNAL 1 2/CS-#16 >> LCP-53062 SIGNAL	S-530-050 S-530-060
S-530-105	530E102	1"	4	2/CS-#16		1	#14	XHHW-2	FR: SIGNAL JUNCTION BOX TO: LCP-53020 1 2/CS-#16 >> AIT-53011 SIGNAL 1 2/CS-#16 >> FIT-53013 SIGNAL 1 2/CS-#16 >> PIT-53062 SIGNAL 1 2/CS-#16 >> PIT-53062 SIGNAL	S-530-035 S-530-015 S-530-015 S-530-055 S-530-055
X-530-105	530E102	1.5"	1	PULL	ROPE				FR: SIGNAL JUNCTION BOX TO: CAPPED EXPOSED ABOVE GROUND LEVEL FLOOR SLAB 1 PULL >>	
X-530-110	530E102	1.5"	1	PULL	ROPE				FR: CONTROL JUNCTION BOX TO: CAPPED EXPOSED ABOVE GROUND LEVEL FLOOR SLAB 1 PULL >>	
		0.75"				1	#14	XHHW-2	FR: TO:	
		0.75"				1	#14	XHHW-2	FR: TO:	
		0.75"				1	#14	XHHW-2	FR: TO:	
		0.75"							FR: TO:	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 26_08_50

FIELD ELECTRICAL ACCEPTANCE TESTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Responsibilities for testing the electrical installation.
   2. Adjusting and calibration.
   3. Acceptance tests.

B. Copyright information:
   1. Some portions of this Section are copyrighted by the InterNational Electrical Testing Association, Inc. (NETA). See NETA publication ATS for details.

1.02 REFERENCES

A. Project references:
   1. Specification sections for the electrical equipment being tested.
   2. Electrical equipment Shop Drawings.

B. Standards:
   1. American National Standards Institute (ANSI).
   2. ASTM International (ASTM):
      a. D877 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
      b. D923 - Standard Practices for Sampling Electrical Insulating Liquids.
      c. D924 - Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
      d. D971 - Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
      e. D974 - Standard Test Method for Acid and Base Number by Color-Indicator Titration.
      f. D1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
      g. D1524 - Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field.
      h. D1533 - Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
      i. D1816 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
      j. D3612 - Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography.
   3. Institute of Electrical and Electronics Engineers (IEEE):
      a. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.

b. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
c. 95 - IEEE Recommended Practice for Insulation Testing of AC Electric Machinery (2,300 V and Above) With High Direct Voltage.
d. 450 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
e. 1106 - IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications.
f. 1188 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.
g. C57.13 - IEEE Standard Requirements for Instrument Transformers.
h. C57.13.1 - IEEE Guide for Field Testing of Relaying Current Transformers.
i. C57.13.3 - IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.
j. C57.104 - IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers.

4. Insulated Cable Engineer's Association (ICEA).
5. InterNational Electrical Testing Association (NETA).
   a. ATS- Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
6. International Electrotechnical Commission (IEC).
7. National Electrical Manufacturers Association (NEMA):
   a. MG1 - Motors and Generators.
8. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code (NEC).
   b. 110 - Standard for Emergency and Standby Power Systems.
9. National Institute of Standards and Technology (NIST).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Testing laboratory: Organization performing the acceptance tests.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Copper Ethernet test form:
   1. Cable test reports:
      a. Submit 3 copies of test reports showing the results of all tests specified in this Section:
         1) Test type.
         2) Test location.
         3) Test date.
         4) Cable number.
         5) Cable length.
         6) Certification that the cable meets or exceeds the specified standard.
      b. Furnish hard copy and electronic copy for all traces.

C. Manufacturers' testing procedures:
   1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer prior to beginning testing.

D. Test report:
   1. Include the following:
      a. Summary of Project.
      b. Description of equipment tested.
      c. Description of tests performed.
      d. Test results.
      e. Conclusions and recommendations.
      f. Completed test forms.
      g. List of test equipment used and calibration dates.
      h. LAN cable test reports.

E. Test data records:
   1. Include the following:
      a. Identification of the testing organization.
      b. Equipment identification.
      c. Nameplate data.
      d. Humidity, temperature and or other conditions that may affect the results of the tests and or calibrations.
      e. Dates of inspections, tests, maintenance and or calibrations.
      f. Indication of the inspections, tests, maintenance, and or calibrations to be performed and recorded.
      g. Expected results when calibrations are to be performed.
      h. Indication of as-found and as-left results as applicable.
      i. Indication of test results outside specified tolerances.

F. Testing laboratory qualifications:
   1. Submit a complete resume and statement of qualifications from the proposed testing laboratory detailing their experiences in performing the tests specified:
      a. This statement will be used to determine whether the laboratory is acceptable, and shall include:
         1) Corporate history and references.
         2) Resume of individual performing test.
         3) Equipment list and test calibration data.

G. Division of responsibilities:
   1. Submit a list identifying who is responsible for performing each portion of the testing.

1.05 QUALITY ASSURANCE

A. Testing laboratory qualifications:
   1. May be qualified testing personnel from the electrical subcontractor's staff or an independent testing company.
   2. NETA certification required.
   3. Selection of the testing laboratory and testing personnel is subject to approval by the Engineer based on testing experience and certifications of the individuals and testing capabilities of the organization.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. General requirements:
   1. Testing of electrical equipment installed under this Contract in accordance with the manufacturer's requirements and as specified in this Section.
   2. Conduct tests in the presence of the Engineer or the Engineer's representative:
      a. Engineer will witness visual, mechanical, and electrical tests, and inspections.
   3. Testing and inspections shall verify that the equipment is operational within the tolerances required and expected by the manufacturer, and these Specifications.

B. Responsibilities:
   1. Contractor responsibilities:
      a. Ensure that resources are made available for testing and that testing requirements are met.
   2. Electrical subcontractor responsibilities:
      a. Perform routine tests during installation.
      b. Demonstrate operation of electrical equipment.
      c. Commission the electrical installation.
      d. Provide the necessary services during testing, and provide these services to the testing laboratory, Contractor, and other subcontractors, including, but not limited to:
         1) Providing electrical power as required.
         2) Operating of electrical equipment in conjunction with testing of other equipment.
         3) Activating and shutting down electrical circuits.
         4) Making and recording electrical measurements.
         5) Replacing blown fuses.
         6) Installing temporary jumpers.
   3. Testing laboratory responsibilities:
      a. Perform acceptance tests specified in this Section.
      b. Provide required equipment, materials, labor, and technical support during acceptance tests.

C. Sequencing:
   1. Prior to testing:
      a. At least 30 days before commencement of the acceptance tests, submit the manufacturer's complete field testing procedures to the Engineer and to the testing laboratory, complete with expected test results and tolerances for equipment to be tested.
   2. Perform testing in the following sequence:
      a. Perform routine tests as the equipment is installed, including:
         1) Insulation-resistance tests.
         2) Continuity tests.
         3) Rotational tests.
      b. Adjusting and preliminary calibration.

c. Acceptance tests.
d. Demonstration.
e. Commissioning and plant start-up.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Test instrument calibration:
   1. Utilize a testing laboratory with a calibration program which maintains applicable test instrumentation within rated accuracy.
      a. Calibrating standard shall be of better accuracy than that of the equipment tested.
   2. Accuracy shall be traceable to the NIST in an unbroken chain.
   3. Calibrate instruments in accordance with the following frequency schedule:
      a. Field instruments: 6 months maximum.
      b. Laboratory instruments: 12 months maximum.
      c. Leased specialty equipment where the accuracy is guaranteed by the lessor (such as Doble): 12 months maximum.
   4. Dated calibration labels shall be visible on test equipment.
   5. Maintain an up-to-date instrument calibration record for each test instrument:
      a. Records shall show the date and results of each calibration or test.
   6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.

B. Requirements prior to testing:
   1. Do not begin testing until the following conditions have been met:
      a. Instruments required are available and in proper operating condition.
      b. Required dispensable materials such as solvents, rags, and brushes are available.
      c. Equipment handling devices such as cranes, vehicles, chain falls, and other lifting equipment are available or scheduled.
      d. Instruction books, calibration curves, or other printed material to cover the electrical devices are available.
      e. Datasheets to record test results are available.

3.02 INSTALLATION

A. Test decal:
   1. Testing laboratory shall affix a test decal on the exterior of equipment or equipment enclosure of protective devices after performing electrical tests.

2. Color coded to communicate the condition of maintenance of the protective. Color scheme for condition of maintenance of overcurrent protective devices shall be:
    a. White: Electrically and mechanically acceptable.
    b. Yellow: Minor deficiency not affecting fault detection and operation, but minor electrical or mechanical condition exists.
3. Shall include the following information at a minimum:
    a. Testing organization.
    b. Project identifier.
    c. Test date.
    d. Technician identifier.

3.03 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning.

B. Functional Testing:
    1. Also called Field Acceptance Testing.

C. Panelboards:
    1. Cleaning:
        a. Visually inspect panelboard for evidence of discoloration, abnormal dust accumulation, metal shards, or any other indication of overheating, wear, or other abnormal conditions prior to cleaning.
        b. Clean cabinet with a brush, vacuum cleaner, or clean, dry, lint-free rags to remove any accumulation of dust, dirt, or other foreign matter. Do not use liquids, solvents or detergents when cleaning panelboards or components.
        c. Avoid blowing dust into panelboards. Do not use a blower or compressed air.
        d. Clean supports, terminals, and other major insulating surfaces with clean, dry, lint-free rags or soft bristled brushes.
        e. Remove dust, soot, grease, moisture, and foreign material from surface of circuit breakers.
    2. General:
        a. Compare equipment nameplate data with the Contract Documents.
        b. Check panelboard circuit schedule for accuracy.
        c. Verify appropriate anchorage, required area clearances, and correct alignment.
        d. Inspect overall general condition for physical damage.
            1) Check for broken studs and loose or damaged wires, connector, terminations, etc.
            2) Check bolts, nuts, washer, and pins for tightness.
            3) Tighten or use manufacturer’s replacement parts as required.
        e. Inspect cabinets for signs of rust, corrosion, or deteriorating paint. Inspect cabinets for evidence of localized heat damage to the paint. Investigate sources of heat. Repair painted surfaces.
        f. Check that covers are in place and fastened. Plug any open unused knockouts.
        g. Inspect panelboard for moisture. Seal off any cracks or openings which have allowed moisture to enter the cabinet. Inspect component devices. Replace any components that show evidence of damage from moisture.

h. Look for any recent changes in sprinklers or other plumbing that might expose indoor panelboards to a source of liquids. Eliminate sources of water, moisture, or liquids, or provide adequate barriers to protect panelboards from sources of water, moisture, or liquids.
i. Inspect panelboards and internal components for evidence of overheating, arc spatter, sooty deposits, and tracking.
    1) Investigate and correct sources of arcing or overheating.
    2) Consult the panelboard manufacturer for recommendations.
j. Verify that fuse and/or circuit breaker sizes and types correspond to record drawings, if available, as well as to the circuit breakers' address for microprocessor communications packages, if equipped.
k. Set adjustable circuit breakers in accordance with engineering coordination study supplied by the Contractor.

3. Terminations, connections, and lugs:
    a. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
            a) Compare bolted connection resistance values to values of similar connections:
                (1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
        2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    b. Inspect terminations, connection, and lugs for alignment, physical damage, burns, corrosion, discoloration, flaking, heat damage, arcing, pitting, melting, deterioration, carbonization, cracks, chips, breaks, partial discharge, or moisture. Investigate and eliminate sources of any damage.
    c. Follow manufacturer recommendations for cleaning, repairing, and replacing damaged parts.
    d. Replace overheated connections. Tighten connections to proper torque levels as specified above.
4. Conductors and raceways:
    a. Inspect supply conductors and terminations for overheating, discoloration, and oxidation. Investigate and correct any deficiencies.
    b. Ensure the conductors are protected within their ampacities.
    c. Visually check panelboard, cables, and raceways for proper bonding and grounding. Correct improper bonding and grounding.
    d. Inspect conductors for discoloration, arcing, pitting, melting, flaking of insulation and/or metal parts. Repair or replace damaged components in accordance with the manufacturer's recommendations.
    e. Inspect for frayed or broken wires. Replace or repair damaged components in accordance with manufacturer recommendations.
    f. Inspect for frayed or broken wires. Replace or repair conductors as necessary.
    g. Inspect conduits for moisture. Seal conduits which are a source of moisture and provide means to drain moisture away from the panelboard.
5. Circuit breakers:
    a. Perform visual and mechanical inspection as specified in this Section.

b. Operate several times in order to exercise the mechanisms and the contacts, and to ensure smooth operation. Do not oil or grease parts of molded case circuit breakers.
c. Visually check for evidence of overheating and thermal damage. Investigate and eliminate sources of overheating.
d. Check for visual defects, chipping, cracks, breaks, burns, and deterioration. Replace damaged circuit breakers.
e. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.
f. Inspect interchangeable trip-unit circuit breakers for tightness of trip units.
g. Check terminals and connections for tightness as specified above.
h. Breakers rated 100 A and higher:
    1) Perform electrical tests as specified in this Section.

D. Dry type transformers:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify that resilient mounts are free and that any shipping brackets have been removed.
    e. Inspect equipment for cleanliness.
    f. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    g. Verify that as-left tap connections are as specified.
2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground:
        1) Apply voltage in accordance with the manufacturer's published data.
            a) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Calculate dielectric absorption ration or polarization index.
    d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral after energization and before loading.
3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.

c. Tap connections are left as found unless otherwise specified.
d. Minimum insulation-resistance values of transformer insulation shall be in accordance with the manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    2) Investigate insulation values less than the allowable minimum.
e. Dielectric absorption ratio or polarization index shall not be less than 1.0.
f. Turns-ratio results should not deviate more than 1/2 percent from either the adjacent coils or calculated ratio.
g. Phase-to-phase and phase-to-neutral secondary voltages shall be in agreement with nameplate data.

E. Low voltage cables, 600 volt maximum:
1. Visual and mechanical inspection:
    a. Compare cable data with the Drawings and Specifications.
    b. Inspect exposed sections of cable for physical damage and correct connection as indicated on the Drawings.
    c. Inspect bolted electrical connections for high resistance by one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    d. Inspect compression applied connectors for correct cable match and indentation.
    e. Inspect for correct identification and arrangement.
    f. Inspect cable jacket insulation and condition.
2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation resistance test on each conductor sized #8 AWG or larger with respect to ground and adjacent conductors:
        1) Applied potential shall be 500 volts DC for 300-volt rated cable and 1,000 volts DC for 600-volt rated cable.
        2) Test duration shall be 1 minute.
    c. Perform continuity tests on power and control conductors to ensure correct cable connection.
    d. Verify uniform resistance of parallel conductors.
3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Insulation-resistance values shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate values of insulation-resistance less than the allowable minimum.

c. Cable shall exhibit continuity.
d. Deviations in resistance between parallel conductors shall be investigated.

F. Low voltage molded case and insulated case circuit breakers:
1. Visual and mechanical inspection:
a. Compare equipment nameplate data with the Contract Documents.
b. Inspect physical and mechanical condition.
c. Inspect anchorage and alignment.
d. Verify the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance by one of the following methods:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
g. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
b. For breakers 100 A and higher:
1) Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole:
a) Apply voltage in accordance with the manufacturer's published data.
b) Refer to NETA ATS tables in the absence of the manufacturer's published data.
2) Perform a contact/pole-resistance test.
3) Determine long-time pickup and delay by primary current injection.
4) Determine short-time pickup and delay by primary current injection.
5) Determine ground-fault pickup and delay by primary current injection.
6) Determine instantaneous pickup value by primary current injection.
7) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with the manufacturer's published data.
8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function and trip unit battery condition:
a) Reset trip logs and indicators.
9) Verify operation of charging mechanism.
3. Test values:
a. Compare bolted connection resistance values to values of similar connections:
1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
1) Refer to NETA ATS tables in the absence of the manufacturer's published data.

c. Insulation-resistance values shall be in accordance with the manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    2) Investigate values of insulation-resistance less than the allowable minimum.
d. Microhm or DC millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
    1) If the manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
e. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed the manufacturer's published time-current characteristic tolerance band, including adjustment factors:
    1) If the manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.
f. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed the manufacturer's published time-current tolerance band.
g. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed the manufacturer's published time-current tolerance band.
h. Instantaneous pickup values shall be as specified and within the manufacturer's published tolerances:
    1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
i. Pickup values and trip characteristics shall be within the manufacturer's published tolerances.
j. Determine energy reducing maintenance switch pickup value by primary current injection.
k. Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
l. Charging mechanism shall operate in accordance with the manufacturer's published data.

G. Instrument transformers - current transformers:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Verify correct connection of transformers with system requirements.
    d. Verify that adequate clearances exist between primary and secondary circuit wiring.
    e. Verify the unit is clean.
    f. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    g. Verify that required grounding and shorting connections provide contact.
    h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1,000 VDC for 1 minute:
        1) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
    c. Perform a polarity test of each current transformer in accordance with IEEE C57.13.1.
    d. Perform a ratio verification test using the voltage or current method in accordance with IEEE C57.13.1.
    e. Perform an excitation test on current transformers used for relaying applications in with accordance with IEEE C57.13.1.
    f. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1.
    g. When applicable, perform insulation-resistance tests on the primary winding with the secondary grounded:
        1) Test voltages shall be in accordance with NETA ATS tables.
    h. Perform power-factor or dissipation-factor tests in accordance with the test equipment manufacturer's published data.
    i. Verify that current transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:
        1) That grounding point should be located as specified by the Engineer in the Contract Documents.
3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Insulation-resistance values of instrument transformers shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    d. Polarity results shall agree with transformer markings.
    e. Ratio errors shall be in accordance with IEEE C57.13.
    f. Excitation results for current transformers shall match the curve supplied by the manufacturer or be in accordance with IEEE C57.13.1.
    g. Measured burdens shall be compared to instrument transformer ratings.
    h. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
    i. Power-factor or dissipation-factor values shall be compared to the manufacturer's published data:
        1) In the absence of the manufacturer's published data, use the test equipment manufacturer's published data.
    j. Test results shall indicate that the circuits have only 1 grounding point.

H. Instrument transformers - voltage transformers:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.
      b. Inspect physical and mechanical condition.
      c. Verify correct connection of transformers with system requirements.
      d. Verify that adequate clearances exist between primary and secondary circuit wiring.
      e. Verify the unit is clean.
      f. Inspect bolted electrical connections for high resistance using one of the following methods:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
      g. Verify that required grounding and connections provide contact.
      h. Verify correct primary and secondary fuse sizes for voltage transformers.
      i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
      j. Perform as-left tests.
   2. Electrical tests - voltage transformers:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      b. Perform insulation-resistance tests winding-to-winding and winding-to-ground:
         1) Test voltage shall be applied for 1 minute in accordance with NETA ATS requirements.
         2) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
      c. Perform a polarity test on each voltage transformer to verify the polarity marks on H_1- X_1 relationship as applicable.
      d. Perform a turns ratio test on all tap positions.
      e. Measure voltage circuit burdens at transformer terminals.
      f. Perform a dielectric withstand test on the primary windings with the secondary windings grounded:
         1) Dielectric voltage shall be in accordance with NETA ATS tables.
         2) Apply the test voltage for 1 minute.
      g. Perform power-factor or dissipation-factor tests in accordance with the test equipment manufacturer's published data.
      h. Verify that voltage transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:
         1) That grounding point should be located as specified by the Engineer in the Contract Documents.
   3. Test values:
      a. Compare bolted connection resistance values to values of similar connections:
         1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
c. Insulation-resistance values of instrument transformers shall be in accordance with the manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
d. Polarity results shall agree with transformer markings.
e. Ratio errors shall be in accordance with IEEE C57.13.
f. Measured burdens shall be compared to instrument transformer ratings.
g. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
h. Power-factor or dissipation-factor values shall be compared to the manufacturer's published data:
    1) In the absence of the manufacturer's published data, use the test equipment manufacturer's published data.
i. Test results shall indicate that the circuits have only 1 grounding point.

I. Metering devices, microprocessor based:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect meters and cases for physical damage.
    c. Clean front panel.
    d. Verify tightness of electrical connections.
    e. Record the following:
        1) Model number.
        2) Serial number.
        3) Firmware revision.
        4) Software revision.
        5) Rated control voltage.
    f. Verify operation of display and indicating devices.
    g. Record passwords.
    h. Verify the unit is grounded in accordance with the manufacturer's instructions.
    i. Set required parameters, including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.
2. Electrical tests:
    a. Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.
    b. Confirm correct operation and setting of each auxiliary input/output feature, including mechanical relay, digital and analog.
    c. After initial system energization, confirm measurements and indications are consistent with loads present.
3. Test values:
    a. Nameplate data shall match the Contract Documents.
    b. Tightness of electrical connections shall ensure a low resistance connection.

c. Display and indicating devices shall operate in accordance with the manufacturer's published data.
d. Measurement and indication of applied voltages and currents shall be within the manufacturer's published tolerances for accuracy.
e. Auxiliary input/output features shall operate in accordance with the settings and the manufacturer's published data.
f. Measure and indications shall be consistent with energized system loads.

J. Grounding systems:
1. Visual and mechanical inspection:
a. Inspect ground system for compliance with the Contract Documents and the NEC.
b. Inspect physical and mechanical condition.
c. Inspect bolted electrical connections for high resistance using one of the following methods:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
d. Inspect anchorage.
2. Electrical tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
b. Perform fall of potential test or alternative test in accordance with IEEE 81 on the main grounding electrode or system.
c. Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, the system neutral and any derived neutral points.
3. Test values:
a. Grounding system electrical and mechanical connections shall be free of corrosion.
b. Compare bolted connection resistance values to values of similar connections:
1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
c. Bolt-torque levels shall be in accordance with the manufacturer's published data:
1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
d. Resistance between the main grounding electrode and ground shall be as specified in Section 26_05_26 - Grounding and Bonding.
e. Investigate point-to-point resistance values that exceed 0.5 ohm.

K. Rotating machinery, AC induction motors and generators:
1. Visual and mechanical inspection:
a. Compare equipment nameplate information with the Contract Documents.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging.

e. Inspect bolted electrical connections for high resistance using one or more of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
        a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
f. Manually rotate the rotor and check for problems with the bearings or shaft.
g. Rotating equipment:
    1) Operate at rated design load conditions.
    2) Confirm that equipment is properly assembled.
    3) Confirm the equipment moves or rotates in the proper direction.
    4) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
    5) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
h. Verify correct application of appropriate lubrication and lubrication systems.
i. Verify that resistance temperature detector (RTD) circuits conform to that indicated on the Drawings.

2. Electrical tests - AC induction:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance test in accordance with IEEE 43:
        1) On motors 200 horsepower and smaller, test duration shall be 1 minute. Calculate dielectric absorption ratio for 60/30-second periods.
        2) On motors larger than 200 horsepower, test duration shall be 10 minutes. Calculate polarization index.
    c. On machines rated at 2,300 volts and greater, perform dielectric withstand voltage tests in accordance with:
        1) IEEE 95 for DC dielectric withstand voltage tests.
        2) NEMA MG1 for AC dielectric withstand voltage tests.
    d. Perform phase-to-phase stator resistance test on machines rated at 2,300 volts and greater.
    e. Perform insulation-resistance test on insulated bearings in accordance with the manufacturer's published data.
    f. Test surge protection devices as specified in this Section.
    g. Test motor starter as specified in this Section.
    h. Perform resistance tests on resistance temperature detector (RTD) circuits.
    i. Verify operation of motor space heater, if applicable.
3. Test values:
    a. Inspection:
        1) Air baffles shall be clean and installed in accordance with the manufacturer's published data.
        2) Filter media shall be clean and installed in accordance with the manufacturer's published data.
        3) Cooling fans shall operate.
        4) Slip ring alignment shall be within the manufacturer's published tolerances.
        5) Brush alignment shall be within the manufacturer's published tolerances.
        6) Brush rigging shall be within the manufacturer's published tolerances.

b. Compare bolted connection resistance values to values of similar connections:
    1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
c. Bolt-torque levels shall be in accordance with the manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
d. Airgap spacing and machine alignment shall be in accordance with the manufacturer's published data.
e. Recommended minimum insulation-resistance ($IR_{1\ min}$) test results in megohms shall be in accordance with NETA ATS tables.
    1) Polarization index value shall not be less than 2.0.
    2) Dielectric absorption ratio shall not be less than 1.4.
f. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
g. Investigate phase-to-phase stator resistance values that deviate by more than 5 percent.
h. Power factor or dissipation factor values shall be compared to the manufacturer's published data:
    1) In the absence of the manufacturer's published data, compare values of similar machines.
i. Tip-up values shall indicate no significant increase in power factor.
j. If no evidence of distress, insulation failure, or waveform nesting is observed by the end of the total time of voltage application during the surge comparison test, the test specimen is considered to have passed the test.
k. Bearing insulation-resistance measurements shall be within manufacturer's published tolerances:
    1) In the absence of the manufacturer's published data, compare values of similar machines.
l. Test results of surge protection devices shall be as specified in this Section.
m. Test results of motor starter equipment shall be as specified in this Section.
n. RTD circuits shall conform to the design intent and machine protection device manufacturer's published data.
o. Heaters shall be operational.
p. Vibration amplitudes of the uncoupled and unloaded machine shall be in accordance with the manufacturer's published data:
    1) In the absence of the manufacturer's published data, vibration amplitudes shall not exceed values in NETA ATS tables.
    2) If values exceed those in the NETA ATS tables, perform a complete vibration analysis.

L. Motor starters, low voltage:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate information with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.

e. Inspect contactors:
    1) Verify mechanical operation.
    2) Verify contact gap, wipe, alignment, and pressure is in accordance with the manufacturer's published data.
f. Motor-running protection:
    1) Verify overload element rating/motor protection settings are correct for its application.
    2) If motor running protection is provided by fuses, verify correct fuse rating.
g. Inspect bolted electrical connections for high resistance using one of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
        a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
h. Lubrication requirements:
    1) Verify appropriate lubrication on moving current-carrying parts.
    2) Verify appropriate lubrication on moving and sliding surfaces.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the starter closed, and across each open pole for 1 minute:
        1) Test voltage shall be in accordance with the manufacturer's published data.
        2) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Test motor protection devices in accordance with the manufacturer's published data.
    d. Test circuit breakers as specified in this Section.
    e. Perform operational tests by initiating control devices.
3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Insulation-resistance values shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate values of insulation-resistance less than the allowable minimum.
    d. Motor protection parameters shall be in accordance with the manufacturer's published data.

e. Circuit breaker test results shall as be specified in this Section.
f. Control devices shall perform in accordance with system design requirements.

M. Motor control centers, low voltage:
1. Visual and mechanical inspection:
a. Compare equipment nameplate data with the Contract Documents.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding and required clearances.
d. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
e. Verify that circuit breaker/fuse sizes and types correspond to the approved Submittals and the coordination study.
f. Verify that current and voltage transformer ratios correspond to those indicated on the Drawings.
g. Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.
h. Inspect bolted electrical connections for high resistance using one of the following methods:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
i. Verify operation and sequencing of interlocking systems:
1) Attempt closure on locked-open devices.
2) Attempt to open locked-closed devices.
3) Make/attempt key-exchanges in all positions.
j. Lubrication requirements:
1) Verify appropriate lubrication on moving current-carrying parts.
2) Verify appropriate lubrication on moving and sliding surfaces.
k. Inspect insulators for evidence of physical damage or contaminated surfaces.
l. Verify correct barrier and shutter installation and operation.
m. Exercise active components.
n. Inspect indicating devices for correct operation.
o. Verify that filters are in place and/or vents are clear.
p. Perform visual and mechanical inspection of instrument transformers as specified in this Section.
q. Perform visual and mechanical inspection of surge arresters as specified in this Section.
r. Inspect control power transformers:
1) Inspect for physical damage, cracked insulation, broken leads, and tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse/circuit breaker ratings match the Submittal Drawings.
3) Verify correction functioning of grounding contacts.
s. Perform visual and mechanical inspection of motor control center components as specified in this Section.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for 1 minute:
        1) Perform test in accordance with NETA ATS tables.
    c. Perform a dielectric withstand test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with the manufacturer's published data or NETA ATS tables. Apply the test voltage for 1 minute.
    d. Perform electrical tests on instrument transformers as specified in this Section.
    e. Perform ground-resistance tests:
        1) Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, system neutral and derived neutral points.
    f. Control power transformers:
        1) Perform insulation-resistance tests, winding-to-winding and winding-to-ground:
            a) Test voltages shall be in accordance with NETA ATS tables or as specified by the manufacturer.
        2) Perform secondary wiring integrity test:
            a) Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source:
                (1) Verify correct potential at all devices.
        3) Verify correct secondary voltage by energizing primary winding with system voltage:
            a) Measure secondary voltage with the secondary wiring disconnected.
    g. Verify operation of space heaters.
    h. Perform electrical tests of motor control center components as specified in this Section.
3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Insulation-resistance values for bus and control power transformers shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate insulation values less than the allowable minimum.
        3) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
    d. Bus insulation shall withstand the over potential test voltage applied.
    e. Instrument transformer test values shall be as specified in this Section.

f. Investigate grounding system point-to-point resistance values that exceed 0.5 ohm.
g. Meter accuracy shall be in accordance with the manufacturer's published data.
h. Control power transformers:
1) Insulation-resistance values of control power transformers shall be in accordance with the manufacturer's published data:
a) Refer to NETA ATS tables in the absence of the manufacturer's published data.
b) Investigate insulation values less than the allowable minimum.
c) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
2) Secondary wiring shall be as indicated on the Drawings and specified in the Specifications.
3) Secondary voltage shall be as indicated on the Drawings.
i. Heaters shall be operational.
j. Test values for motor control center components shall be as specified in this Section.

N. Variable frequency drive systems:
1. Visual and mechanical inspection:
a. Compare equipment nameplate data with the Contract Documents.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Ensure vent path openings are free from debris and that heat transfer surfaces are clean.
f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
g. Motor running protection:
1) Verify drive overcurrent setpoints are correct for their application.
2) If drive is used to operate multiple motors, verify individual overload element ratings are correct for their application.
3) Apply minimum and maximum speed setpoints. Verify setpoints are within limitations of the load coupled to the motor.
h. Inspect bolted electrical connections for high resistance using one of the following methods:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
i. Verify correct fuse sizing in accordance with the manufacturer's published data.
j. Perform visual and mechanical inspection of input circuit breaker as specified in this Section.
2. Electrical tests:
a. Perform resistance measurements through bolted connections with low resistance ohmmeter.
b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

c. Test for the following parameters in accordance with relay calibration procedures specified in NETA ATS, or as recommended by the manufacturer:
    1) Input phase loss protection.
    2) Input overvoltage protection.
    3) Output phase rotation.
    4) Overtemperature protection.
    5) Direct current overvoltage protection.
    6) Overfrequency protection.
    7) Drive overload protection.
    8) Fault alarm outputs.
d. Harmonic distortion measurements for both voltage and current is within the specification limits at the installed site.
e. Peak voltage at the motor terminations is less than 90 percent of the motor insulation dielectric withstand level.
f. Perform continuity tests on bonding conductors as specified in accordance with NETA ATS.
g. Perform start-up of drive in accordance with the manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.
h. Perform operational tests by initiating control devices:
    1) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
    2) Verify operation of drive from remote start/stop and speed control signals.
i. Perform electrical tests of input circuit breaker as specified in this Section.
j. Measure fuse resistance.

3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Overload test trip times at 300 percent of overload element rating shall be in accordance with the manufacturer's published time-current curve.
    d. Test values for input circuit breaker shall be as specified in this Section.
    e. Relay calibration results shall be as specified in this Section.
    f. Continuity of bonding conductors shall be in accordance with NETA ATS.
    g. Control devices shall perform in accordance with system requirements.
    h. Operational tests shall conform to system design requirements.
    i. Investigate fuse resistance values that deviate from each other by more than 15 percent.

O. Surge arresters, low-voltage:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and clearances.

d. Verify the arresters are clean.
e. Inspect bolted electrical connections for high resistance using one of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
        a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
f. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
g. Verify that stroke counter is correctly mounted and electrically connected, if applicable.
h. Record stroke counter reading.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform an insulation-resistance test on each arrester, phase terminal-to-ground:
        1) Apply voltage in accordance with manufacturer's published data.
        2) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Test grounding connection as specified in this Section.
3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Insulation-resistance values shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate insulation values less than the allowable minimum.
    d. Resistance between the arrester ground terminal and the ground system shall be less than 0.5 ohm.

P. Uninterruptible power systems:
1. Testing and settings shall be conducted by the UPS manufacturer's field engineer. Test the complete operation of:
    a. Static transfer system.
    b. Static bypass system.
    c. Maintenance bypass system.
2. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify that fuse sizes and types correspond to that indicated on the Drawings.

e. Verify the unit is clean.
f. Test electrical and mechanical interlock systems for correct operation and sequencing.
g. Inspect bolted electrical connections for high resistance using one of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
        a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
h. Verify operation of forced ventilation.
i. Verify that filters are in place and/or vents are clear.

3. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Test static transfer from inverter to bypass and back. Use normal load, if possible.
    c. Set free running frequency of oscillator.
    d. Test DC undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.
    e. Test alarm circuits.
    f. Verify synchronizing indicators for static switch and bypass switches.
    g. Perform electrical tests for:
        1) UPS system breakers as specified in this Section.
        2) UPS system automatic transfer switches as specified in this Section.
        3) UPS system batteries as specified in this Section.
        4) UPS rotating machinery as specified in this Section.

4. Test values:
    a. Electrical and mechanical interlock systems shall operate in accordance with system design requirements.
    b. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    c. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    d. Static transfer shall function in accordance with the manufacturer's published data.
    e. Oscillator free running frequency shall be within the manufacturer's published tolerances.
    f. Direct current undervoltage shall trip inverter input breaker.
    g. Alarm circuits shall operate in accordance with design requirements.
    h. Synchronizing indicators shall operate in accordance with design requirements.
    i. Breaker performance shall be as specified in this Section.
    j. Automatic transfer switch performance shall be as specified in this Section.
    k. Battery test results shall be as specified in this Section.
    l. Rotating machinery performance shall be as specified in this Section.

Q. Automatic transfer switches:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding, and required clearances.
      d. Verify the unit is clean.
      e. Lubrication requirements:
         1) Verify appropriate lubrication on moving current-carrying parts.
         2) Verify appropriate lubrication on moving and sliding surfaces.
      f. Verify that manual transfer warnings are attached and visible.
      g. Verify tightness of control connections.
      h. Inspect bolted electrical connections for high resistance using one of the following methods:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
      i. Perform manual transfer operation.
      j. Verify positive mechanical interlocking between normal and alternate sources.
   2. Electrical tests:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      b. Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with switch in both source positions and across each open pole. Test voltage shall be in accordance with the manufacturer's published data:
         1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      c. Perform a contact/pole-resistance test.
      d. Verify settings and operation of control devices.
      e. Calibrate and set relays and timers as specified in this Section.
      f. Verify phase rotation, phasing, and synchronized operation as required by the application.
      g. Perform automatic transfer tests:
         1) Simulate loss of normal power.
         2) Return to normal power.
         3) Simulate loss of emergency power.
         4) Simulate all forms of single-phase conditions.
      h. Verify correct operation and timing of the following functions:
         1) Normal source voltage-sensing and frequency-sensing relays.
         2) Engine start sequence.
         3) Time delay upon transfer.
         4) Alternate source voltage-sensing and frequency-sensing relays.
         5) Automatic transfer operation.
         6) Interlocks and limit switch function.
         7) Time delay and retransfer upon normal power restoration.
         8) Engine cool down and shutdown feature.

3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Insulation resistance values of transfer switches shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Values of insulation resistance less than this table or the manufacturer's recommendations shall be investigated.
    d. Microhm or DC millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
        1) If the manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    e. Control devices shall operate in accordance with the manufacturer's published data.
    f. Relay test results shall be as specified in this Section.
    g. Phase rotation, phasing, and synchronization shall be as specified in the system design specifications.
    h. Operation and timing shall be in accordance with the manufacturer's and system design requirements.

R. Switches, air, low-voltage:
    1. Visual and mechanical inspection:
        a. Compare equipment nameplate data with the Contract Documents.
        b. Inspect physical and mechanical condition.
        c. Inspect anchorage, alignment, grounding, and required clearances.
        d. Verify the unit is clean.
        e. Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.
        f. Verify that fuse sizes and types as indicated on the Drawings, short-circuit studies, and coordination study.
        g. Verify that each fuse has adequate mechanical support and contact integrity.
        h. Inspect bolted electrical connections for high resistance using one of the following methods:
            1) Use of a low resistance ohmmeter.
            2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
                a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
        i. Verify operation and sequencing of interlocking systems.
        j. Verify correct phase barrier installation.
        k. Verify correct operation of indicating and control devices.
        l. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Measure contact resistance across each switchblade and fuse holder.
    c. Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with the manufacturer's published data:
        1) In the absence of the manufacturer's published data, use NETA ATS requirements.
    d. Measure fuse resistance.
    e. Verify cubicle space heater operation.
    f. Perform ground fault test as specified in this Section, if applicable.
    g. Perform tests on other protective devices as specified in this Section, if applicable.
3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connection by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
4. Test values - electrical:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Microhm or DC millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
        1) If the manufacturer's published data is not available, investigate values which deviate from those of similar bus connections and sections by more than 50 percent of the lowest value.
    c. Insulation-resistance values shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate insulation values less than the allowable minimum.
    d. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
    e. Heaters shall be operational.
    f. Ground fault tests shall be as specified in this Section.
    g. Results of protective device tests shall be as specified in this Section.

S. Fiber-optic cables:
1. Visual and mechanical inspection:
    a. Compare cable, connector, and splice data with the Contract Documents.
    b. Inspect cable and connections for physical and mechanical damage.
    c. Verify that connectors and splices are correctly installed.

2. Optical tests:
    a. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer (OTDR):
        1) OTDR test performed on fiber cables less than 100 meters shall be performed with the aid of a launch cable.
        2) Adjust OTDR pulse width settings to a maximum setting of 1/1,000th of the cable length or 10 nanoseconds.
    b. Perform connector and splice integrity test using an optical time domain reflectometer.
    c. Perform cable attenuation loss measurement with an optical power loss test set:
        1) Perform attenuation tests with an optical loss test set capable and calibrated to show anomalies of 0.1 dB as a minimum.
        2) Test multimode fibers at 850 nanometer and 1,300 nanometer.
        3) Test single mode fibers at 1,310 nanometer and 1,550 nanometer.
    d. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set:
        1) At the conclusion of all outdoor splices at 1 location, and before they are enclosed and sealed, splices shall be tested with OTDR at the optimal wavelengths (850 and 1,300 for multimode, 1,310 and 1,550 for single mode), in both directions. Splices shall be tested for integrity as well as attenuation.
    e. Perform fiber links integrity and attenuation tests using each link shall be an OTDR and an optical loss test set:
        1) OTDR traces shall be from both directions on each fiber at the 2 optimal wavelengths, 850 nanometer, and 1,300 nanometer for multimode fibers.
        2) Optical loss testing shall be done with handheld test sets in 1 direction at the 2 optimal wavelengths for the appropriate fiber type. Test equipment shall equal or exceed the accuracy and resolution of Agilent/HP 8147 high performance OTDR.
3. Test values:
    a. Cable and connections shall not have been subjected to physical or mechanical damage.
    b. Connectors and splices shall be installed in accordance with industry standards.
    c. Optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.
    d. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer’s recommendations when no local site specifications are available.
    e. Individual fusion splice losses shall not exceed 0.1 dB. Measurement results shall be recorded, validated by trace, and filed with the records of the respective cable runs.

T. Copper Ethernet cable installation testing:
1. Pre-installation:
    a. Immediately prior to installation, verify that cable to be installed matches that which was submitted.

b. Verify that no damage has been done to the cable during shipping or handling.
c. Inspect cable for physical and mechanical damage.
d. Engineer shall be notified if a cable fails to meet inspection and the cable shall not be installed unless otherwise directed by the Engineer.

2. Post-installation:
   a. Prior to copper Ethernet cable termination, perform cable end-to-end continuity validation testing on installed cables, conductor pairs and cable shields using toner and probe kit. Any cable that fails testing shall be removed and replaced.
   b. Inspect equipment outlet connectors for damage and ensure connectors hold tightly in field device ports.
3. Test equipment:
   a. Certification equipment used for the testing shall be capable of verifying twisted pair cable installation with end-to-end continuity testing.
   b. Use only test cords and adapters that are qualified by the test equipment manufacturer for channel or link test configuration.
   c. Manufacturers: The following or equal:
      1) Fluke Networks, IntelliTone Pro 200 Toner and Probe Kit, MT-8200-60-KIT.
   d. Permanent link testing requirements: As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 CLEANING

A. Dispose of testing expendables.

B. Vacuum cabinets.

C. Sweep clean surrounding areas.

END OF SECTION

SECTION 26_09_13

ELECTRICAL POWER MONITORING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Power meters and accessories.

1.02 REFERENCES

A. American National Standard Institute (ANSI):
   1. C12.20 - Electricity Meters - 0.2 and 0.5 Accuracy Classes.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. C57.13.6 - Standard for High Accuracy Instrument Transformers.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. FS - Full scale.
   2. SSM - Solid state multifunction power meter.
   3. THD - Total harmonic distortion.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Power meter data, including, but not limited to:
      a. Power requirements.
      b. Communications protocols.
      c. Input/outputs.
      d. Dimensions.
      e. Measurement functions.
      f. Front panel controls.
      g. Display characteristics.
   2. Accessory data:
      a. Test switch dimensions and wiring diagrams.

C. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

D. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
   2. Descriptive and technical bulletins and sales aids edited to reflect only the equipment to be provided and covering each of the components in the system.

3. A maintenance section including instruction leaflets and technical data necessary to setup, change setup and maintain the power meters.
4. Original licensed copies of software and software manuals.

E. Configuration files and reports:
1. Settings, including, but not limited to:
a. Device tag name.
b. IP addresses.
c. Alarm settings.
d. Time synchronization settings.
e. Security settings.
2. Configuration files are to be provided in the selected manufacturer's native format.
3. Configuration reports are to be submitted in .PDF format, listing each configured parameter setting and description of each parameter.

1.05 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
1. ABB.
2. Allen-Bradley.
3. Eaton.
4. Electro Industries/GaugeTech Power Meters.
5. GE Multilin.
6. Schneider Electric.

2.02 COMPONENTS

A. Power meters:
1. Power meter analyzer (SSM2) device shall be used in all equipment and shall include at a minimum:
a. Individual phase currents, within 0.2 percent FS.
b. Phase-to-phase and phase-to-neutral voltages, within 0.2 percent FS.
c. Watts, VARs, VA, within 0.4 percent FS.
d. Watt-hours 0.5 percent OR; VAR-hours 1 percent OR; VA-hours 0.5 percent OR.
e. PF apparent 0.8 percent FS; PF displacement 0.8 percent FS.
f. Frequency, 0.04 percent, or 0.01 hertz.
g. THD:
1) Voltage - 50th harmonic.
2) Current - 50th harmonic.

h. Demand:
    1) Ampere, within 0.2 percent FS.
    2) Watt, VAR, VA, within 0.4 percent FS.
i. Revenue accuracy in accordance with ANSI C12.20 0.2 class.
j. Minimum and maximum values:
    1) Volts (L-L), volts (L-N), current (L, N, G), watts, VARs, VA.
    2) PF (apparent and displacement).
    3) Frequency.
    4) THD-amps, THD-volts.
    5) Demand:
        a) Ampere, watt, VAR, VA.
k. Trend analysis:
    1) Time/date.
l. Event logging:
    1) 504 events with time stamp.
m. Disturbance recording:
    1) 10 waveform events.
n. Inputs/outputs:
    1) 4 Form C relays, rated 10 amps.
    2) Four 0 to 10/4 to 20 milliamperes analog outputs.
    3) 3 plus 30 VDC differential discrete inputs.
    4) One 0 to 20/4 to 20 milliamperes analog input.
o. Kilowatt hour pulse initiator.
p. Waveform display - local/computer.
q. Frequency distribution display - local/computer.
r. Synch-Input kilowatt utility.
s. Graphic LCD with LED backlight.
t. Communications:
    1) Modbus TCP.

2.03 ACCESSORIES

A. Current transformers:
    1. Ring type:
        a. Suitable for service within low or medium voltage equipment as indicated on the Drawings.
        b. Designed to have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the equipment of the application.
    2. Current ratio: As indicated on the Drawings.
    3. Rated in accordance with IEEE C57.13.6 with accuracy of the current transformers suitable for relay accuracy class and rated for 200 percent burden for the required connected devices.
    4. Identify polarity with standard marking or symbols.
    5. Capable of carrying rated primary current continuously without damage.
    6. Install secondary wiring from current transformers in a suitable wiring trough, or conduit to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.
    7. 3 CTs for 3-wire systems. 4CTs for 4-wire systems.

B. Voltage transformers:
   1. Indoor dry type, single-phase, 60 hertz, with a minimum thermal capacity of not less than 400 volt-amperes at 55 degrees Celsius rise above 40 degrees Celsius ambient.
   2. Accuracy classification determined in accordance with IEEE C57.13.6, suitable for relay accuracy class, and 200 percent burden, for the required connected devices, with the secondary voltage 120 volts.
   3. Insulation levels as required for the equipment system voltage but not less than:
      a. 600 VAC, 10 kV BIL for 480 VAC systems.
      b. 5.6 kV, 60 kV BIL for 2300 and 4160 VAC systems.
      c. 15.5 kV, 110 kV BIL for 12.47 kV and 13.2 kV systems.
   4. Identify polarity with standard markings or symbols.
   5. Connect transformer secondary to voltage buses as required.
   6. Provide primary and secondary current-limiting fuses.

C. Test switches:
   1. Ten-pole:
      a. 3 voltage poles, for phase voltage:
         1) 600 V rated.
      b. Four 30 A, non-shorting current poles, for neutral current and let-thru phase currents.
      c. Three 30 A, shorting current poles, for shorting phase currents.
   2. Base to be made of electrical grade plastic.
   3. Barriers between poles for pole isolation and separation.
   4. Clear cover encapsulating the test switch to enable visual verification of each switch position.
   5. Knife-blade type switches, accepting a horizontal gang interlocking bar.
   6. Screw type terminals on each switch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install power meters in accordance with the manufacturer’s instructions in the electrical equipment as indicated on the Drawings.

3.02 FIELD QUALITY CONTROL

A. Field electrical acceptance testing:
   1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

3.03 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations 2.
      b. Maintenance 2.

END OF SECTION

SECTION 26_22_14

DRY-TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Enclosed dry-type transformers:
      a. Rated 1 to 1,000 kilovolt-amperes, single and 3-phase.
      b. Primary voltage 600 volts and below.

1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):
   1. 389 - IEEE Recommended Practice for Testing Electronics Transformers and Inductors.
   2. C57.96 - IEEE Guide for Loading Dry-Type Distribution and Power Transformers.

B. Underwriters Laboratory (UL):
   1. 1561 - Standard for Dry-Type General Purpose and Power Transformers.

C. United States Department of Energy (DOE):
   1. 10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment.

1.03 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Nameplate data.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   4. Inrush current.
   5. Insulation system and temperature constraints.
   6. Number and rating of taps.
   7. Sound levels.

8. Connection diagrams:
    a. Primary.
    b. Secondary.
9. BIL rating.
10. Required clearances.
11. Percent impedance.
12. Efficiency.
13. Certification of full capacity capability at the Project elevation and ambient conditions.
14. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01_81_50 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Delegated Design Submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria:
    a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
    b. For equipment installed outdoors.

D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. Provide manufacturer's installation instructions.

E. Quality Control Submittals:
1. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.

1.05 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.

B. Provide 3-phase or 1-phase, 60 hertz dry-type with voltage ratings, kilovolt-ampere capacities, and connections as indicated on the Drawings:
   1. Transformers shall provide full capacity at the Project elevation and environmental conditions as specified in Section 01_81_50 - Design Criteria after all derating factors have been applied.
   2. Suitable for continuous operation at full rating with normal life expectancy in accordance with IEEE C57.96.

2.02 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Jefferson.
   4. Schneider Electric.

2.03 MATERIALS

A. Cores:
   1. Non-aging, grain-oriented silicon steel.
   2. Magnetic flux densities below the saturation point.

B. Windings:
   1. High-grade magnet wire.
   2. Impregnated assembly with non-hydroscopic, thermo-setting varnish:
      a. Cured to reduce hot-spots and seal out moisture.
   3. Material electrical grade:
      a. Copper.

2.04 EQUIPMENT

A. General:
   1. 10 kilovolts BIL for 600-volt class windings.
   2. Sound levels, in accordance with IEEE 389 test conditions, not to exceed:

Kilovolt-Amperes Range	Audible Sound Level (dB)
1-9	40
10-50	45
51-150	50
151-300	55
301-500	60
501-700	62
701-1,000	64

   3. Taps:
      a. 15 kilovolt-amperes and less:
         1) Two 5 percent full capacity primary taps below rated voltage.

b. 25 kilovolt-amperes and larger:
1) Four 2.5 percent full capacity primary taps below rated voltage.
2) Two 2.5 percent full capacity primary taps above rated voltage.
c. Operated by a tap changer handle or tap jumpers accessible through a panel.
4. Terminals:
a. UL listed for either copper or aluminum conductors.
b. Rated for 75 degrees Celsius.
5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with IEEE C57.96.

B. Transformers less than 15 kilovolt-amperes:
1. Insulation class: 185 degrees Celsius.
2. Temperature rise: 115 degrees Celsius.

C. Energy efficient transformers 15 kilovolt-amperes and larger:
1. Insulation class: 220 degrees Celsius.
2. Temperature rise: 80 degrees Celsius, except as noted below:
a. 150-degree Celsius rise for dry-type transformers located in motor control centers.
3. Efficiency:
a. In accordance with DOE 10 CFR Part 431.

D. Enclosures:
1. Heavy gauge steel:
a. Indoor: NEMA Type 2.
2. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50 degrees Celsius.
3. Built-in vibration dampeners to isolate the core and coils from the enclosure:
a. Neoprene vibration pads and sleeves.

2.05 ACCESSORIES

A. Nameplates:
1. Non-corrosive metal or UL listed non-metallic:
a. Stamped, engraved or printed with the following information:
1) Phases.
2) Frequency.
3) Kilovolt-ampere rating.
4) Voltage ratings.
5) Temperature rise.
6) Impedance.
7) Insulation class.
8) BIL rating.
9) Connection diagram.
10) Weight.
11) Manufacturer.
12) Identification “transformer”.
13) Classes of cooling.
14) Tap voltage(s).
15) Vector diagram.

2.06 FINISHES

A. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposited manufacturer's standard gray enamel rust-inhibiting paint.

2.07 SOURCE QUALITY CONTROL

A. Factory tests:
   1. Applied voltage test to each winding and from each winding to the core:
      a. 600-volt class winding 4.5 kilovolt.
   2. Induced voltage test at 2 times normal voltage and 400 hertz for 1,080 cycles.
   3. Voltage ratio and polarity.
   4. Sound level, performed in a test room with ambient sound level not exceeding 24 dB.
   5. Perform tests in accordance with UL 1561.
   6. Furnish test reports and Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Mounted as indicated on the Drawings.
   2. Install where not in direct contact with building structure.
   3. Install on single layer vibration pad under the entire mounting surface:
      a. Manufacturers: The following or equal:
         1) Korfund.
   4. Make any necessary connections to the enclosure with liquidtight flexible conduit having neoprene gaskets and insulated ground bushings.
   5. Ground the enclosure:
      a. To an equipment ground conductor in the conduit.
      b. To the facility grounding electrode system.
   6. Floor mounted transformers:
      a. Install transformers on a housekeeping pads.
      b. Install transformers with adequate space from walls or other enclosures for proper ventilation in accordance with the manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

A. Field electrical acceptance testing:
   1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

3.04 ADJUSTING

A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

END OF SECTION

SECTION 26_24_16

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Panelboards serving feeder circuits and branch circuits.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

C. Underwriters Laboratories, Inc. (UL):
   1. 67 - Standard for Panelboards.

1.03 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Manufacturer of panelboard.
   2. Bill of material.
   3. Assembly ratings including:
      a. Voltage.
      b. Phase.
      c. Continuous current.
      d. Short circuit interrupting rating.
   4. NEMA enclosure type.
   5. Cable terminal sizes based upon actual feeder and sub-feeder conductors used.
   6. Furnish circuit breaker Submittals as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
   7. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01_81_50 - Design Criteria:
      a. Manufacturer’s statement of seismic qualification with substantiating test data.
      b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop Drawings:
    1. Overall panelboard dimensions, interior panel dimensions, and wiring gutter dimensions:
        a. Height.
        b. Length.
        c. Width.
    2. Weight.
    3. Anchoring locations.
    4. Breaker layout drawing with dimensions:
        a. Location of the main, branches, solid neutral, and ground.
    5. Conduit entry/exit locations:
        a. Identify conduit entry/exit locations and restrictions.
    6. Individual panel schedules identifying breaker locations, ratings, and nameplate designations within the panelboard, for every panelboard.

D. Calculations:
    1. Detailed calculations or details of the actual physical testing performed on the panelboard to prove the panelboard is suitable for the seismic requirements at the Project Site.

E. Delegated Design Submittals:
    1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria:
        a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
        b. For equipment installed outdoors.
        c. For wall mounted equipment weighing 125 pounds or more.

F. Installation instructions:
    1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
    2. Provide manufacturer’s installation instructions.

G. Quality Control Submittals:
    1. Manufacturer’s Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
    2. Test reports.

H. Operations and maintenance manual:
    1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
    2. Provide a complete manual for the operation and maintenance of the panelboard, circuit breakers, devices, and accessories:
        a. Including, but not limited to:
            1) Instruction narratives and bulletins.
            2) Renewal parts lists.
            3) Time-current curves for all devices.

1.05 QUALITY ASSURANCE

A. Where indicated as service entrance equipment, panelboards shall be UL listed and labeled “Suitable for Service Entrance.”

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Circuit breaker panelboards as indicated in the panelboard schedules, one-lines, and where indicated on the Drawings:
   1. Service voltage and configuration as indicated on the panel schedules.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer’s specified operating ranges.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Schneider Electric.

B. Circuit breakers:
   1. Same manufacturer as the panelboard.

2.04 EQUIPMENT

A. Provide panelboards with:
   1. Molded-case circuit breakers with trip ratings as shown on the panel schedules.
   2. Spares and spaces for future circuit breakers in panels as shown on the panel schedules.
      a. Space for future devices as specified in Section 26_05_00 - Common Work Requirements for Electrical.

B. Short circuit rating:
   1. Provide as indicated on the Drawings.
   2. Testing method in accordance with UL 67.
   3. Mark each panelboard with its maximum short circuit rating at the supply voltage.
   4. Panelboards shall be fully rated.

2.05 COMPONENTS

A. Enclosure:
   1. NEMA enclosure type as indicated on the Drawings:
      a. Where not indicated on the Drawings, as specified in Section 26_05_00 - Common Work Results for Electrical for the installed location.
   2. Minimum width: 20 inches.
   3. Gutter space in accordance with the NEC:
      a. Minimum of 4 inches.
   4. Dead-front, no live parts when the panelboard is in service.
   5. Enclose entire panelboard bus assembly in a corrosion resistant galvanized steel cabinet.
   6. 4-piece front to provide ease of wiring access.
   7. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull:
      a. Minimum 2 keys per panelboard.
   8. Circuit directory frame and card on the inside of the door.
   9. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.
   10. Outdoor locations: Provide NEMA Type 4X enclosures with a NEMA Type 4X stainless steel outer enclosure (with a hinged door) and a NEMA Type 1 interior panelboard, unless otherwise indicated.

B. Bus:
   1. General:
      a. Tin-plated copper.
   2. Phase bus:
      a. Full size and height without reduction.
      b. Dimensions and temperature rise in accordance with UL 67:
         1) Limit current density to less than 1,000 amps per square inch.
      c. Insulate current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.
   3. Ground bus:
      a. Copper, solidly bonded.

4. Neutral bus:
    a. Provide where indicated on the Drawings.
    b. 200 percent rated.
    c. Provide lugs for each outgoing feeder requiring a neutral connection.
5. Provide insulation barriers over the vertical bus behind the dead front shield to provide increased safety during field service.

C. Lugs:
1. UL listed for copper and aluminum wire:
    a. Rated for 75-degree Celsius terminations.
    b. Provide bolted or compression main lug terminations as required for the incoming cable size.

D. Circuit breakers: As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers and as indicated on the Drawings:
1. Provide with bolt-on connections:
    a. Plug-in circuit breakers are not allowed.

2.06 ACCESSORIES

A. Surge protective devices:
1. Furnish panelboards with surge protective devices as indicated on the Drawings.
2. As specified in Section 26_43_14 - Surge Protective Devices.

B. Nameplates:
1. As specified in Section 26_05_53 - Identification for Electrical Systems.
2. Install on outside of door.
3. Indicating:
    a. Panel designation.
    b. Voltage.
    c. Number of phases and configuration.

C. Circuit identification labels:
1. Provide index cards behind heavy clear plastic in cardholders on the inside of the doors.
2. Type all information on the cards using designations in the panel schedules.
3. Laminated on both sides.

D. Pad locking mechanism:
1. Provide a pad locking attachment to allow circuit breakers to be locked in the off position.
2. At a minimum, provide 1 mechanism per panelboard:
    a. Provide multiple mechanisms if required to accommodate all circuit breaker frame sizes in the panelboard.

2.07 FINISHES

A. Finish stand-alone panelboards with a primer, rust-resistant phosphate undercoat, and 2 coats of oven-baked enamel with manufacturer's standard gray.

B. Finish panelboards mounted in motor control centers to match the motor control center finish and color.

2.08 SOURCE QUALITY CONTROL

A. Source Testing:
   1. Perform standard factory tests on the panelboards.
   2. Test in accordance with NEMA and UL standards.
   3. Furnish test reports and Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Mounted as indicated on the Drawings.
   2. Mount rigidly to structural members with exposed surfaces plumb and level to within 1/32 inch.
   3. Perform Work in accordance with the manufacturer's instructions and Shop Drawings.
   4. Provide brackets, hangers, supports, and hardware for mounting as required.
   5. In NEMA Type 4 and NEMA Type 4X locations, mount panelboards on 7/8-inch deep stainless steel preformed channel, with channel running vertically from top to bottom of panelboard:
      a. Use only stainless steel mounting hardware.
   6. Mount panelboard so that top operating handle is not more than 6 feet-7 inches above the operating floor.

C. Provide typewritten schedule in each panelboard.

3.03 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

END OF SECTION

SECTION 26_24_20

LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage motor control centers.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. ICS 18-2001 - Motor Control Centers.

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

C. Underwriters Laboratories (UL):
   1. 845 - Motor Control Centers.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. SELV: Safety extra-low voltage.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Manufacturer of motor control center.
   2. Manufacturer of motor control center parts.
   3. Nameplate schedule.
   4. Bill of material.
   5. Enclosure:
      a. NEMA rating.
      b. Finish color.
   6. Ratings:
      a. Voltage.
      b. Phase.

c. Current:
1) Horizontal bus ampacity.
2) Vertical bus ampacity.
3) Ground bus ampacity.
d. Short circuit withstand rating.
e. Protective device interrupting rating.
7. List of recommended spare parts.
8. Catalog cutsheets:
a. Submit complete manufacturer's catalog information:
1) Clearly indicate the features of the equipment, including any options necessary to meet the required functionality.
9. Furnish component Submittals as specified in the appropriate Section.
10. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01_81_50 - Design Criteria:
a. Manufacturer's statement of seismic qualification with substantiating test data.
b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
1. Layout drawings:
a. Provide fully dimensioned and to scale layout drawings which include:
1) Dimensions:
a) Overall length.
b) Overall width.
c) Overall height.
d) Overall weight and weight of individual shipping splits.
2. Interfaces to other equipment.
3. Shipping splits.
4. Allowable top and bottom conduit windows.
5. Complete component and unit layout drawings, including control, networking, and metering components.
6. Indicate lug sizes, type, and manufacturer based on the cable size specified in the Contract Documents and as indicated on the Drawings.
7. Elementary schematics:
a. Provide 1 custom schematic diagram for each compartment:
1) Include remote devices.
2) Show wire numbers on the schematics:
a) Provide wire numbering as specified in Section 26_05_53 - Identification for Electrical Systems.
8. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
9. One-line diagrams:
a. Provide complete one-line diagrams for each motor control center, including, but not limited to: Protective devices, starters, drives, metering, and other equipment.
b. Indicate electrical ratings of the equipment shown on the one-line diagrams.

D. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the motor control center to prove the motor control center is suitable for the seismic requirements at the Project Site.

E. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria:
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.

F. Installation instructions:
   1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
   2. Provide manufacturer's installation instructions.

G. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
   3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.

H. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

I. Operation and maintenance manuals:
   1. Provide complete operating and maintenance instructions presenting full details for care and maintenance of all types of equipment furnished and/or installed under this Section. Include the following:
      a. Electrical ratings:
         1) Phase.
         2) Wire.
         3) Voltage.
         4) Ampacity.
         5) Bus bracing and protective device interrupting ratings.
      b. Manufacturer's operating and maintenance instructions for the motor control center and component parts, including:
         1) Starters.
         2) Overload relays and heater elements.
         3) Variable frequency drives.
         4) Protective devices, including, but not limited to, fuses, circuit breakers and protective relays.
         5) Pilot devices.
      c. Complete renewal parts list.

J. Test forms and reports:
   1. Submit complete factory acceptance test procedures and forms used during the test.

K. Record documents:
    1. Elementary schematics:
        a. Furnish as-built elementary schematics indicating final:
            1) Wire numbers.
            2) Interfaces with other equipment.
        b. Provide 1 custom schematic diagram for each compartment:
            1) Include remote devices.
            2) Show wire numbers on the schematics.
        c. Layout drawings: Provide complete dimensioned component and unit layout drawings.
    2. Record documents shall reflect modifications made during the submittal review process and during construction.

1.06 QUALITY ASSURANCE

A. All portions of the motor control center, vertical bays, and components shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the motor control center and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on-site off-loading equipment.

B. Furnish temporary equipment heaters within the motor control center to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
    1. Conduct the initial fault current study as specified in Section 26_05_74 - Electrical System Studies and submit results for the Engineer’s review.
    2. After successful review of the initial fault current study, as specified in Section 26_05_74 - Electrical System Studies, submit complete equipment submittal.
    3. Conduct factory acceptance test.
    4. Submit manufacturer’s test results.
    5. Ship equipment to the Project Site after successful completion of factory acceptance test.
    6. Assemble equipment in the field.
    7. Conduct field acceptance test and submit results for the Engineer’s review.
    8. Submit manufacturer’s certification that the equipment has been properly installed and is fully functional for the Engineer’s review.
    9. Conduct Owner’s Training sessions.
    10. Commissioning and process start-up as specified in Section 01_75_17 - Commissioning.

1.10 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Factory assembled, factory wired and factory tested motor control centers:
   1. Motor control centers and major components to be products of a single manufacturer.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.

2.03 MANUFACTURERS

A. Motor Control Centers, one of the following or equal:
   1. ABB.
   2. Allen-Bradley.
   3. Eaton.
   4. Schneider Electric.

2.04 EQUIPMENT

A. General:
   1. Furnish motor control centers as specified in the Contract Documents and indicated on the Drawings.
   2. Arrange the equipped sections to form continuous motor control center lineups as indicated on the Drawings:
      a. Identify any deviations from the Drawings in writing and submit for approval.
   3. Provide wire markers at each end of every wire as specified in Section 26_05_53 - Identification for Electrical Systems.
   4. Provide complete and functional motor control centers.
   5. Provide devices or accessories not specified in this Section but necessary for the proper installation and operation of the equipment.

B. Design and construct motor control center to operate at the voltage level and configuration indicated on the Drawings.

C. Bus system:
   1. Material:
      a. Tin-plated copper.
      b. Short-circuit rating:
         1) As indicated on the Drawings.

c. Bus bar supports:
1) High impact strength, non-tracking glass-polyester material that is impervious to moisture and gases.

2. Horizontal power bus:
a. Current-carrying capacity as indicated on the Drawings.
b. Mounting:
1) Mount horizontal bus bars edgewise, one above the other, and fully isolated from wireways and units.
c. Temperature rise:
1) In accordance with UL 845.
2) De-rate the temperature rating of the bus for the specified conditions of ambient temperature and altitude as specified in Section 01_81_50 - Design Criteria.

3. Vertical power bus:
a. Current-carrying capacity of not less than 600 amps.
b. Mounting:
1) Enclose the vertical bus in a polyester-glass cover with small openings to permit unit stabs to mate with the bus:
a) Provide a shutter mechanism to cover the stab openings when plug-in units are removed.
2) Provide top and bottom bus covers for insulation and isolation of the ends of the bus.
c. Isolated from the unit compartments by a full height barrier.

4. Ground bus:
a. Horizontal ground bus:
1) Current-carrying capacity:
a) 300 amps when the horizontal bus is 2,000 amps or less.
b) 600 amps when the horizontal bus is greater than 2,000 amps.
2) Mounting:
a) Full width, firmly secured to each vertical section structure:
(1) Located in the top or bottom wireway.
b) Pre-drilled and furnished with lugs for connection to equipment ground wires:
(1) Furnish a minimum of 10 lugs per vertical section of MCC.
b. Vertical ground bus:
1) Mounting:
a) Furnish in each vertical section.
b) Bolted to the horizontal ground bus.
c) Install parallel to the vertical power bus.
d) Mount vertical ground bus such that plug-in units engage the ground bus before any connection to the power bus is made. Upon removal of plug-in units, ground stabs are disconnected from the ground bus after the power stabs have been disconnected.

5. Bus splice bars:
a. Provided to join the bus at the splits.
b. Connected to each horizontal bus bar with a minimum of 2 bolts.
c. Employ conical or spring washers at connections, designed to maintain constant pressure against the splice joint.
d. Same ampacity rating as the horizontal bus.

6. Provide bus system configured for back-to-back MCCs, where required.

D. Enclosures:
   1. Each motor control center shall consist of one or more vertical sections bolted together:
      a. Freestanding.
      b. Totally enclosed.
      c. Dead-front assembly.
      d. Designed for modification and/or addition of future vertical sections.
      e. Form each vertical section of heavy gauge steel.
   2. Enclosure rating:
      a. Indoor:
         1) NEMA Type 1 gasketed.
   3. Standard section dimensions:
      a. Nominal height: 90 inches.
      b. Nominal depth: 20 inches.
      c. Vertical section width as indicated on the Drawings.
   4. Wireways:
      a. Provide each vertical section with a horizontal wireway at the top and bottom of the section:
         1) Arranged to provide a full-width metal enclosed wiring trough across the entire motor control center assembly.
      b. Provide each vertical section with a full-height vertical wireway.
      c. Completely isolated from the vertical and horizontal bus bars.
      d. Provide a removable, hinged door.
   5. Shipping splits:
      a. No more than 3 vertical sections and not more than 60 inches in width.
      b. Solid bussing between vertical sections in a shipping split is not acceptable.
   6. Lifting angles:
      a. Furnish each vertical section and/or shipping split with a removable lifting angle mounted to the top of the enclosure:
         1) Extending the entire width of the shipping split.
   7. Mounting channels:
      a. Mount each vertical section and/or shipping split on an external 1.5-inch by 3-inch mounting channel.

E. Units:
   1. A plug-in unit consists of:
      a. Assembly.
      b. Support pan.
      c. Door assembly.
   2. Completely enclosed and isolated from adjacent units, buses, and wireways, except for conductor entries into the unit, by a metal enclosure.
   3. Supported and guided by a removable unit support pan:
      a. Re-arrangement of units and the removal of a unit so that a new and possibly larger unit can be added without the removal of an in-service unit to gain access to the unit support pan.
   4. Held in place by screws or other positive locking means after insertion.
   5. Provide a test position with the unit supported in the structure but disengaged from the bus.
   6. Integral plug-in ground stab.
   7. Stabs:
      a. Free floating.

b. Self-aligning.
c. Backed by spring steel clips to ensure high pressure contacts.
d. Electrolytically tin-plated copper.

8. Handle:
   a. Provide a flange mounted handle mechanism to operate each disconnect switch or circuit breaker.
   b. Door mounted operators or operator handles are not acceptable.
   c. Engaged with the disconnect device at all times as an integral part of the unit independent of the door position.
   d. Lockable in the “OFF” position with up to 3 padlocks.
   e. Mechanically interlocked so that the door cannot be opened with the handle in the “ON” position:
      1) Provide a means for qualified personnel to defeat this interlock.
   f. Interlocked so the unit cannot be inserted or withdrawn with the handle in the “ON” position.
   g. Lockable in the “ON” position:
      1) This shall not prevent the circuit breaker from operating and opening the contacts in the event of a fault condition.
   h. Color-coded to indicate position.
   i. Located so the center of the grip when it is in its highest position is not more than 6 feet-7 inches above the finished floor, including the height of the housekeeping pad and mounting channels.
9. Space for future devices:
   a. Provide spaces as indicated on the Drawings.
   b. As specified in Section 26_05_00 - Common Work Requirements for Electrical.

2.05 COMPONENTS

A. Provide components contained within the motor control center as specified in:
   1. Section 26_05_53 - Identification for Electrical Systems.
   2. Section 26_05_18 - 600-Volt or Less Wires and Cables.
   3. Section 26_05_21 - Low Voltage Wire Connections.
   4. Section 26_09_13 - Electrical Power Monitoring.
   5. Section 26_29_24 - Variable Frequency Drives 0.50 - 50 Horsepower.
   6. Section 26_43_14 - Surge Protective Devices.
   7. Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
   8. Section 26_29_05 - Motor Starters.
   9. Section 26_28_14 - Low Voltage Fuses.
   10. Section 40_67_01 - Control Systems: Panels, Enclosures, and Panel Components.

B. The following electrical safety devices as specified in Section 26_43_10 - Electrical Safety Devices:
   1. I/R window as indicated on the Drawings.
   2. Absence/presence of voltage detectors as indicated on the Drawings.

2.06 ACCESSORIES

A. Wiring:
   1. Wire the motor control center in accordance with the following NEMA class and type as defined by NEMA ICS 18-2001:
      a. NEMA Class II-S:
         1) Furnish wiring diagrams for individual units consisting of drawings that identify electrical devices, electrical connections, and indicate terminal numbering designations.
         2) Furnish individual unit diagrams with each unit and include inter-wiring between units, i.e., electrical interlocking, etc., as specifically specified in the Contract Documents.
         3) Provide custom drawings with unique terminal numbering designations in lieu of standard manufacturer drawings.
      b. NEMA Type B wiring:
         1) Control wiring:
            a) Type B-T pull-apart terminal blocks.
         2) Power wiring:
            a) Type B-T for Size 1 starters.
            b) Type B-T or B-D for Size 2 and 3 starters.
            c) Type B for Size 4 and larger starters and feeder units.

B. Lugs and terminals:
   1. For external connections of No. 6 AWG wire or larger:
      a. UL listed for copper or aluminum conductors.
   2. Compression type, requiring a hydraulic press and die for installation.
   3. Provide additional terminal blocks as needed for control conductors passing through the MCC.
   4. Provide 30 percent spare control block terminals.

C. Nameplates:
   1. Provide nameplates as specified in Section 26_05_53 - Identification for Electrical Systems:
      a. Identifying the motor control center designation as indicated on the Drawings.
   2. Furnish individual nameplates for each unit indicated on the Drawings:
      a. 1 nameplate to identify the unit designation.
      b. 1 nameplate to identify the load served.
      c. Furnish space units with blank nameplates.
   3. Manufacturer’s labels:
      a. Furnish each vertical section with a label identifying:
         1) Serial number.
         2) Bus rating.
         3) Vertical section reference number.
         4) Date of manufacture.
         5) Catalog number of section.

2.07 FINISHES

A. Finish metal surfaces and structural parts with phosphatizing, or equal, treatment before painting.

B. Finish interior surfaces, including bus support angles, control unit back plates, and top and bottom barrier plates with baked white enamel.

C. Finish exterior of enclosure with the manufacturer's standard gray.
   1. Finish NEMA Type 3R exterior cabinets with ultraviolet resistant enamel paint that is UL recognized for outdoor use.

2.08 SOURCE QUALITY CONTROL

A. Source Testing (Factory Acceptance Tests):
   1. Witnessed, virtual only.
   2. Test the complete motor control center at the manufacturer's establishment. Completely assemble, wire and test the motor control center:
      a. Detailed inspections before and after assembly to ensure correctness of design and workmanship.
   3. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.
   4. Furnish test reports and Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish cables, conduit, lugs, bolts, and other accessories necessary to completely install the motor control center for the line, load, and control connections.
   2. Assemble and install the motor control center in the locations and with the layouts as indicated on the Drawings.
   3. Make bus splice connections.
   4. Perform Work in accordance with the manufacturer's instruction and Shop Drawings.
   5. Furnish components and equipment necessary to complete the installation.
   6. Replace hardware, lost or damaged during installation or handling, in order to provide a complete installation.

7. Install the MCC on a raised concrete housekeeping pad:
    a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units:
        1) Remove the manufacturer's supplied mounting channels as required by the manufacturer's installation instructions.
    b. Weld and/or bolt the motor control center frame to leveling channels.

C. Provide openings in the top or bottom of the motor control center for conduit only:
    1. No additional openings will be accepted:
        a. Miscut holes will require that the entire vertical section or removable panel be replaced.
        b. No hole closers or patches will be accepted.

D. Bundle circuits together and terminate in each unit:
    1. Tie with nylon wire ties as specified in Section 26_05_18 - 600-Volt or Less Wires and Cables.
    2. Label wires at each end with wire markers as specified in Section 26_05_53 - Identification for Electrical Systems as shown on the approved elementary schematics.

E. Furnish Manufacturer's Certificate of Installation Verification.

3.03 FIELD QUALITY CONTROL

A. Functional Testing:
    1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

B. Manufacturer's services:
    1. Provide the services of a manufacturer's representative to:
        a. Inspect, verify, and certify that the motor control center installation meets the manufacturer's requirements.

3.04 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
    1. Number of sessions:
        a. Operations: 2.
        b. Maintenance: 2.

3.05 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

END OF SECTION

SECTION 26_27_26

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Switches.
   2. Receptacles.
   3. Device cover wall plates.

1.02 REFERENCES

A. Federal Specifications (FS):
   1. W-C-596 - Connector, Electrical, Power, General Specification for.
   2. W-S-896/2 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

D. Telecommunications Industry Association (TIA):
   1. T568A - Eight-position jack pin/pair assignment.
   2. T568B - Optional eight-position jack pin/pair assignment.

E. Underwriters Laboratories, Inc. (UL):
   1. 20 - General Use Snap Switches.
   2. 498 - Standard for Attachment Plugs and Receptacles.
   3. 943 - Ground-Fault Circuit-Interrupters.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. GFCI: Ground fault circuit interrupter.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.

C. Shop Drawings:
    1. Engraving schedule:
        a. Furnish complete engraving schedule for engraved nameplates.

1.05 QUALITY ASSURANCE

A. Wiring devices shall be UL listed and labeled.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Switches, receptacles, and device cover wall plates as indicated on the Drawings, wired and operable to form a complete system.

2.02 MANUFACTURERS

A. Switches:
    1. One of the following or equal:
        a. Cooper Wiring Devices.
        b. Hubbell.
        c. Leviton.

B. Receptacles:
    1. General purpose:
        a. One of the following or equal:
            1) Cooper Wiring Devices.
            2) Hubbell.
            3) Leviton.
    2. Hazardous areas:
        a. One of the following or equal:
            1) Appleton.
            2) Crouse-Hinds.

C. Device cover wall plates:
    1. General location:
        a. One of the following or equal:
            1) Cooper Wiring Devices.
            2) Legrand.
    2. Wet or corrosive areas:
        a. One of the following or equal:
            1) ABB.

2) Cooper Wiring Devices.
3) Hubbell.
4) Pass and Seymour.

3. In-use covers:
   a. One of the following or equal:
      1) ABB.
      2) Cooper Wiring Devices.
      3) Pass and Seymour.
      4) TayMac.

2.03 MANUFACTURED UNITS

A. Switches:
   1. General:
      a. 120 to 277 VAC.
      b. 20 amp.
      c. Listed in accordance with UL 20.
      d. Designed and constructed in accordance with FS W-S-896/2.
      e. Back and side wired unless otherwise indicated.
      f. Integral grounding terminal.
      g. Totally enclosed:
         1) Color-coded body with color corresponding to amp rating.
      h. Provide switches with the operator style and contact arrangement as indicated on the Drawings and as required for proper operation.
      i. Color:
         1) Ivory in finished areas.
         2) Brown in all other areas.
   2. General purpose switches:
      a. Toggle type.
   3. Switches for use with photocell:
      a. Maintained contact.
      b. 2 circuit.
      c. 3 position:
         1) Center off.

B. Receptacles:
   1. General purpose receptacles:
      a. Single or duplex as indicated on the Drawings.
      b. 125 VAC.
      c. 20 amp or as indicated on the Drawings.
      d. NEMA Type 5-20R configuration for 20 amp receptacles.
      e. Other NEMA configurations as indicated on the Drawings.
      f. Listed in accordance with UL 498.
      g. Designed and constructed in accordance with FS W-C-596.
      h. Back and side wired.
      i. 1-piece, rivet-less mounting strap.
      j. Color:
         1) Ivory in finished areas.
         2) Brown in all other areas.
         3) Orange when powered by a UPS.

2. Ground fault interrupter receptacles (GFCI):
    a. 125 VAC.
    b. 20 amp.
    c. Trip level 4 to 6 mA.
    d. Individual and feed through protection.
    e. UL 943 and UL 498 listed.
    f. NEMA Type 5-20R configuration.
    g. For damp or wet locations:
        1) Weather resistant, in accordance with UL 498.
3. Receptacles for hazardous areas:
    a. 125 VAC.
    b. 20 amp.
    c. Factory sealed.
    d. Single receptacle.
    e. 2-wire, 3-pole.
    f. Grounded through extra pole and shell.
    g. Dead-front construction.
    h. Interlocked to prevent plug from being withdrawn until circuit has been broken.

C. Device cover wall plates:
1. General location:
    a. Type 302 or 304 stainless steel.
    b. Brushed satin finish.
    c. Minimum thickness: 0.032 inches.
    d. Rectangular or square shape.
    e. Engraving:
        1) Engrave each switch device cover wall plate with the following:
            a) Area served.
            b) Panelboard and Circuit.
        2) Engrave each receptacle device cover wall plate with the following:
            a) Panelboard and Circuit.
        3) Treat engraving to improve visibility.
        4) Characters shall be block letter pantograph engraved with a minimum character height of 1/8-inch.
    f. Coordinate the number of gangs, number, and type of openings with the specific location.
2. Outdoor and wet areas requiring NEMA Type 4 or NEMA Type 4X enclosures:
    a. General:
        1) UL listed for wet locations.
        2) Gasketed.
        3) Die cast metal:
            a) Match material to box material.
    b. Switches:
        1) Lever operated:
            a) Provide toggle switch.
    c. Receptacles:
        1) Weatherproof in-use cover:
            a) Die cast metal construction with electrostatic powder coating for corrosion resistance.
            b) Gasketed.

c) Lockable.
d) UL listed and in accordance with the NEC.

3. Corrosive areas:
   a. Neoprene.
   b. Gasketed.
   c. Weatherproof.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mounting heights:
   1. Process and production areas:
      a. Switches and receptacles: 48 inches from finished floor to top of device cover wall plate.
   2. Offices and finished areas:
      a. Switches: 48 inches from finished floor to top of device cover wall plate.
      b. Receptacles: 18 inches from finished floor to center of device cover wall plate.

B. Switches:
   1. Over 300 volts:
      a. Where switches used in systems of more than 300 volts between conductors, are to be ganged in outlet boxes, provide switches having no exposed live parts or use barriers between the individual switches.

C. Receptacles:
   1. Provide GFCI receptacles as indicated on the Drawings.
      a. Provide weather resistant GFCI receptacles in wet or damp areas.
   2. Mount receptacles vertically:
      a. Ground slot down.
   3. 3-phase receptacles shall be consistent with respect to phase connection at the receptacle terminals. Correct errors in phasing at the source and not the receptacle.

D. Ensure device cover wall plates make a firm seal with wall for recessed mounted devices:
   1. Outside edges of device cover wall plates parallel with building lines.

END OF SECTION

SECTION 26_28_01

LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage molded case circuit breakers.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

B. Underwriters Laboratories (UL):
   1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.03 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Manufacturer’s time-current curves for molded case circuit breakers furnished.

C. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria.
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

D. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

1.05 QUALITY ASSURANCE

A. Low voltage molded case circuit breakers shall be UL listed and labeled.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Molded case thermal magnetic, solid-state, or motor circuit protector type circuit breakers as indicated on the Drawings and connected to form a completed system.

2.02 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Schneider Electric.

2.03 MANUFACTURED UNITS

A. General:
   1. In accordance with UL 489.
   2. Operating mechanism:
      a. Quick-make, quick-break, non-welding silver alloy contacts.
      b. Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.
      c. Mechanically trip free from the handle.
      d. Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
      e. Lockable in the “OFF” position.
   3. Arc extinction:
      a. In arc chutes.
   4. Voltage and current ratings:
      a. Minimum ratings as indicated on the Drawings.
      b. Minimum frame size 100A.
   5. Interrupting ratings:
      a. Minimum ratings as indicated on the Drawings.
      b. Modify as required to meet requirements of the short circuit fault analysis as specified in Section 26_05_74 - Electrical System Studies.
      c. Not less than the rating of the assembly (panelboard, switchboard, motor control center, etc.).

B. Motor circuit protectors:
   1. Instantaneous only circuit breaker as part of a listed combination motor controller.
   2. Each pole continuously adjustable in a linear scale with “LO” and “HI” settings factory calibrated.

2.04 COMPONENTS

A. Terminals:
   1. Line and load terminals suitable for the conductor type, size, and number of conductors indicated on the Drawings and in accordance with UL 489.

B. Case:
   1. Molded polyester glass reinforced.
   2. Ratings clearly marked.

C. Trip units:
   1. Provide thermal magnetic or solid-state trip units as indicated on the Drawings.
   2. Thermal magnetic:
      a. Instantaneous short circuit protection.
      b. Inverse time delay overload.
      c. Ambient or enclosure compensated by means of a bimetallic element.
   3. Solid state:
      a. With the following settings as indicated on the Drawings:
         1) Adjustable long time current setting.
         2) Adjustable long time delay.
         3) Adjustable short time pickup.
         4) Adjustable short time delay.
         5) Adjustable instantaneous pickup.
         6) Adjustable ground fault pickup as indicated on the Drawings.
         7) Adjustable ground fault delay as indicated on the Drawings.

D. Provide ground fault trip devices as indicated on the Drawings.

E. Molded case circuit breakers for use in panelboards:
   1. Bolt-on type:
      a. Plug-in type breakers are not acceptable.
   2. Ground fault trip devices as indicated on the Drawings.

2.05 ACCESSORIES

A. Auxiliary switches:
   1. Provide open/closed status switches for remote monitoring of breaker as indicated on the Drawings.

B. Alarm switches:
   1. Provide normally open contact that is actuated when breaker trips as indicated on the Drawings.

C. Lockable handle:
   1. Provide assembly to lock operating handle in “OPEN” position.
   2. Where a molded case circuit breaker is located in a dedicated enclosure, provide a lockable handle. Reference the Electrical Specifications for additional locking requirements associated with other mounting installations.

2.06 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
   1. UL 489.
   2. Manufacturer's standard testing procedures.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install breakers to correspond to the accepted Shop Drawings.

3.03 FIELD QUALITY CONTROL

A. Field electrical acceptance testing:
   1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

3.04 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations 2.
      b. Maintenance 2.

3.05 ADJUSTING

A. Adjust trip settings in accordance with Protective Device Coordination Study as accepted by the Engineer and in accordance with manufacturer's recommendations.

B. Adjust motor circuit protectors in accordance with NEC and the manufacturer's recommendation based on the nameplate values of the installed motor.

END OF SECTION

SECTION 26_28_14

LOW VOLTAGE FUSES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fuses: 600-volt class and lower.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Catalog cut sheets.
   2. Complete fuse schedule.
   3. Manufacturer original 11-inch by 17-inch, time current curves for all fuses furnished.

C. Shop Drawings:
   1. Include drawings of spare fuse cabinets.

1.04 QUALITY ASSURANCE

A. Low voltage fuses shall be UL listed and labeled.

1.05 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.06 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.07 MAINTENANCE

A. Spare parts:
   1. Provide 3 spare fuses for each size and type used or supplied under any Section of the Contract Documents.
   2. Provide spare fuse cabinet(s):
      a. Metal cabinet with hinged door and shelves or fuse holders.
      b. Gray enamel finish.
      c. Mount near equipment and label “Spare Fuses” on face of cabinet.

d. Suitable pocket inside door of each cabinet with typewritten spare fuse inventory in clear plastic protective insert.
e. Provide as many cabinets as required to hold entire spare fuse inventory.

PART 2 PRODUCTS

2.01 GENERAL

A. Fuses for overcurrent protection and/or current limiting applications as indicated on the Drawings.

2.02 MANUFACTURERS

A. One of the following or equal:
1. Bussmann.
2. Ferraz Shawmut.
3. Littelfuse.

2.03 MANUFACTURED UNITS

A. General:
1. Provide durable, readily visible label inside each fuse enclosure, clearly indicating the correct type, size, and ratings of replacement fuse:
a. Label shall not cover or interfere with the equipment manufacturer's instructions.
2. Affix a label indicating recommended torque for fuse mounting bolts or studs to the inside of fuse access doors.
3. To ensure selective coordination of protective devices:
a. Provide fuses for new facilities by the same manufacturer.
b. Provide fuses for renovations of the same manufacturer as existing fuses.
4. Provide fuses rated for the voltage and available short circuit current at which they are applied.

B. Fuses for services, switchboard mains, feeders, and branch circuits:
1. 600 amperes and less:
a. Provide UL listed RK1 dual-element, time-delay fuses with ampere ratings as indicated on the Drawings, except as may be modified by the Contract Documents.
2. 601 to 6,000 amperes:
a. Provide UL listed Class L fuses.

C. Fuses for motor branch circuits:
1. Ampere ratings shall not exceed the motor controller manufacturer's recommended values:
a. If the manufacturer does not have such standards, provide fuses as specified in this Section.
2. Provide Class RK1 fuses or fuses as indicated on the Drawings and as specified in the Contract Documents, rated in accordance with the fuse manufacturer's recommendations for backup running protection of motor circuits containing overload relays.

3. Determine fuse ratings for overload protection of motor branch circuits by actual full-load currents of motors provided.
4. Fuses in motor control centers may be time-delay Class J or Class CC fuses, if MCC manufacturer's standard designs use these fuse types:
    a. Time-delay Class J fuse ratings shall not exceed 150 percent of motor full load current except as permitted.
    b. Follow the fuse manufacturer's recommendations for Class CC fuses.
    c. A motor having starting duty or other special characteristics requiring larger fuses than specified above may have branch circuit fuse ratings increased as necessary to meet the motor's requirements, but no larger than maximum permitted by the NEC.
        1) Increased requirements for an individual motor shall not be cause for increasing size of all fuses.
5. Provide Class L fuses for motor branch circuits requiring fuses over 600 amps, sized at 150 percent of motor full load current except as permitted below:
    a. A motor having starting duty or other special characteristics requiring larger fuses than specified above, may have branch circuit fuse ratings increased as necessary to meet the motor's requirements, but no larger than maximum permitted by the NEC.
        1) Increased requirements for an individual motor shall not be cause for increasing size of all fuses.

D. Fusing of control circuits:
1. Provide:
    a. RK1 fuses installed in UL listed Class CC fuse blocks as specified in the Contract Documents.
2. Provide minimum protection for control circuits in accordance with the latest revision of UL 508 for Industrial Control.
3. Fuse both the primary and secondary circuit of control power transformers:
    a. Fuse ratings shall be in accordance with NEC requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Properly aligned, electrically and mechanically secure.
2. Evenly torque mounting bolts and nuts to ASTM recommendations for type and diameter of mounting bolts or studs provided.
3. Paralleling of fuses is not permitted.
4. Install fuses so that the fuse nameplate and rating are easily readable in the equipment.

B. Replace fuses, on all phases, for any fuses that opened during start-up and testing.

C. After completion of testing, deliver spare fuses in quantities specified:
1. New, in manufacturer's original packaging, and stored in a clean, dry location.

D. Install spare fuse cabinets where instructed by the Owner.

END OF SECTION

SECTION 26_28_17

DISCONNECT SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Knife blade fusible and non-fusible disconnect switches.
   2. Switch-rated plugs and receptacles.

1.02 REFERENCES

A. National Electric Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. KS 1-2001 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. Underwriters Laboratories Inc. (UL):
   1. 98 - Enclosed and Dead-Front Switches.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Safety switches and disconnect switches are to be considered synonymous.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Manufacturer.
   2. Manufacturer’s specifications and description.
   3. Ratings:
      a. Voltage.
      b. Current.
      c. Horsepower.
      d. Short circuit rating.
   4. Fused or non-fused.
   5. NEMA enclosure type.
   6. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   7. Weight.
   8. Cross-referenced to the disconnect schedule indicated on the Drawings.

C. Shop Drawings:
   1. Manufacturer's installation instructions:
      a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance, Regulatory Requirements below.
      b. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
   2. For each switch, indicate nameplate inscription, including voltage, circuit, fuse size (if applicable), and equipment served.

D. Installation instructions:
   1. Provide manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

A. Regulatory requirements:
   1. NEMA Type KS 1- Enclosed and Miscellaneous Distribution Switches (600 V Maximum).
   2. UL 98 - Enclosed and Dead-Front Switches.

B. Disconnect switches shall be UL listed and labeled.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct the initial fault current study as specified in Section 26_05_74 - Electrical System Studies and submit results for the Engineer's review.
   2. After successful review of the initial fault current study, submit complete equipment Submittal.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide knife blade disconnect switches and switch-rated plugs and receptacles as indicated on the Drawings and specified in the Contract Documents.

B. Provide equipment with the number of poles, voltage, current, short circuit, and horsepower ratings as required by the load and the power system.

2.02 MANUFACTURERS

A. Knife-blade disconnect switches:
   1. One of the following or equal:
      a. ABB.
      b. Appleton.
      c. Crouse-Hinds.
      d. Eaton.
      e. Schneider Electric.
      f. Siemens.

2.03 EQUIPMENT

A. Knife-blade style switch disconnects:
   1. Switch mechanism:
      a. Quick-make, quick-break heavy-duty operating mechanisms:
         1) Provisions for padlocking the switch in the Off position.
         2) A minimum of 90-degree handle travel position between Off and On positions:
            a) Provide handle position indicators to identify the handle position.
         3) Full cover interlock to prevent opening of the switch door in the On position and to prevent closing the switch mechanism with the door open:
            a) With an externally operated override.
   2. Switch interior:
      a. Switch blades visible when the switch is Off and the cover is open.
      b. Lugs:
         1) Front accessible.
         2) Removable.
         3) UL listed for 60/75-degree Celsius copper conductors.
      c. Current carrying parts completely plated to resist corrosion.
      d. Removable arc suppressors to facilitate easy access to line side lugs.
      e. Furnish equipment ground kits for every switch.
   3. Fused switches:
      a. Furnish with fuses as indicated on the Drawings:
         1) Provide fuses as specified in Section 26_28_14 - Low Voltage Fuses.
      b. UL approved for field conversion from standard Class H fuse spacing to Class J fuse spacing:
         1) Ratings 100 amps through 600 amps at 240 volts.
         2) Ratings 30 amps through 600 amps at 600 volts.
         3) Provide spring reinforced and plated fuse clips.
   4. Ratings:
      a. UL horsepower rated for AC or DC with the rating not less than the load served.
      b. Current:
         1) 30 to 1,200 amps.
      c. Voltage:
         1) 250 volts AC, DC.
         2) 600 volts (30 A to 200 A, 600 volts DC).
      d. Poles:
         1) 2, 3, 4, and 6 poles.

e. UL listed short circuit ratings:
    1) 10,000 RMS symmetrical amps when used with or protected by Class H or K fuses (30 to 600 amps).
    2) 200,000 RMS symmetrical amps when used with or protected by Class R or J fuses (30 to 600 amps employing appropriate fuse rejection).
    3) 200,000 RMS symmetrical amps when used with or protected by Class L fuses (800 to 1,200 amps).

B. Where not indicated on the Drawings, provide switches with the NEMA ratings specified in Section 26_05_00 - Common Work Results for Electrical for the installed location.

C. Size, fusing and number poles as indicated on the Drawings or as required:
    1. Provide solid neutral where indicated on the Drawings.

2.04 ACCESSORIES

A. Disconnect switches to have provisions for a field installable “B” type electrical interlock for position indication as indicated on the Drawings.

B. Disconnect switches to have provisions for a field installed insulated groundable neutral kit as indicated on the Drawings.

C. NEMA Type 7 and Type 9 enclosures furnished with drain and breather kit when used in outdoor applications.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
    1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
    2. Install anchors of type and material indicated on approved anchoring designs.
    3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
    1. Use Myers hubs or bolt-on hubs for conduit penetrations on NEMA Type 12, Type 4, and Type 4X enclosures.
    2. Provide mounting brackets, stands, supports and hardware as required:
        a. Match finish and materials for brackets, stands, and hardware with the switch installed.
        b. Provide adequate supporting pillar(s) for disconnect switches in accordance with the approved seismic calculations, and locate aboveground or above decks, where there is no structural wall or surface for box.

3. When possible, mount switches rigidly to exposed building structure or equipment structural members:
    a. For NEMA Type 4 and Type 4X locations, maintain a minimum of 7/8 inch air space between the enclosure and supporting surface.
    b. When mounting on preformed channel, position channel vertically so that water may freely run behind the enclosure.
4. Provide a nameplate for each disconnect switch:
    a. As specified in Section 26_05_53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
    1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

END OF SECTION

SECTION 26_29_05

MOTOR STARTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Motor starters and contactors.

1.02 REFERENCES

A. Abbreviations:
   1. FVNR: Full voltage non-reversing.
   2. FVR: Full voltage reversing.

B. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE).
   2. International Electrotechnical Commission (IEC):
      a. 801-1 - Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment - Part 1: General Information.
      b. 947-4 - Low-Voltage Switchgear and Control Gear.
   3. National Electrical Manufacturer's Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
      b. ICS 2-230 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V.
   4. Underwriters Laboratories, Inc. (UL):
      a. 508 - Standard for Industrial Control Equipment.
      b. 508A - Standard for Industrial Control Panels.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Overload relay class: A classification of an overload relay time current characteristic by means of a number which designates the maximum time in seconds at which it will operate when carrying a current equal to 600 percent of its current rating.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures:
   1. Submit motor starter data with equipment Submittal.

B. Product data:
   1. Manufacturer.
   2. Catalog cutsheets.
   3. Technical information.
   4. Complete nameplate schedule.
   5. Complete bill of material.
   6. List of recommended spare parts.
   7. Confirmation that the overload relay class for each starter meets the requirements of the equipment and motor supplier.
   8. Electrical ratings:
      a. Phase.
      b. Wire.
      c. Voltage.
      d. Ampacity.
      e. Horsepower.
   9. Furnish circuit breaker submittals as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

C. Shop Drawings:
   1. Elementary and schematic diagrams:
      a. Provide 1 diagram for every starter and contactor.
      b. Indicate wire numbers for control wires on the diagrams:
         1) Wire numbering as specified in Section 26_05_53 - Identification for Electrical Systems.
      c. Indicate interfaces with other equipment on the Drawings.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria:
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

E. Quality Control Submittals:
   1. Manufacturer’s representative qualifications.
   2. Manufacturer’s Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
   3. Test reports.

F. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

G. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.

2. Submit complete operating and maintenance instructions presenting full details for care and maintenance of equipment furnished or installed under this Section, including, but not limited to:
    a. Electrical ratings:
        1) Phase.
        2) Wire.
        3) Voltage.
        4) Ampacity.
    b. Complete bill of material.
    c. Manufacturer's operating and maintenance instructions starter and/or contactor component parts, including:
        1) Protective devices (fuses, breakers, overload relays, heater elements, etc.).
        2) Pilot devices.
    d. Complete renewal parts list.
    e. As-built drawings:
        1) Furnish as-built drawings for each starter and contactor indicating final:
            a) Wire numbers.
            b) Interfaces with other equipment.
        2) 11-inch by 17-inch format.

1.06 QUALITY ASSURANCE

A. Regulatory requirements:
    1. Starters and components shall be UL listed and labeled:
        a. UL 508 - Industrial Control Equipment.
        b. UL 508A - Industrial Control Panels.
    2. NEMA ICS 2 - Industrial Control and System Controllers; Contactors and Overload Relays Rated: 600 Volts.
    3. Combination starters shall be UL listed and labeled.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

A. Spare parts:
    1. Provide the following spare parts, suitably packaged and labeled with the corresponding equipment number:
        a. 1 spare fuse of each size and type per starter.

PART 2 PRODUCTS

2.01 GENERAL

A. Starters for motor control centers, individual enclosed starters, or control panels.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. For equipment located in non-conditioned spaces, provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. NEMA starters and contactors:
      a. ABB.
      b. Allen-Bradley.
      c. Eaton.
      d. Schneider Electric.

2.04 MANUFACTURED UNITS

A. General:
   1. Provide combination type starters with motor circuit protector or thermal-magnetic circuit breaker and control power transformer with ratings as indicated on the Drawings.
   2. NEMA size, design, and rated:
      a. NEMA Size 1 minimum.
   3. Coordinate motor circuit protector, thermal magnetic circuit breaker, or fusible disconnect, and overload trip ratings with nameplate horsepower and current ratings of the installed motor.
      a. If motors provided are different in horsepower rating than those specified or indicated on the Drawings, provide starters coordinated to the actual motors furnished.
   4. Provide starters NEMA Size 2 and larger with arc quenchers on load breaking contacts.
   5. Mount extended overload reset buttons to be accessible for operation without opening starter enclosure door.

B. Full voltage starters (FVNR, FVR):
   1. Across-the-line full voltage magnetic starters.
   2. Rated for 600 volts.
   3. Electrical characteristics as indicated on the Drawings.
   4. Provide positive, quick-make, quick-break mechanisms, padlockable enclosure doors.
   5. Furnish starter with [bi-metallic][solid state electronic] overload relays.
   6. Double-break silver alloy contacts.
   7. Reversing starters provided with both mechanical and electrical interlocks to prevent line shorts and energizing both contactors simultaneously.

2.05 COMPONENTS

A. Molded case circuit breakers:
   1. Circuit breaker type and ratings as indicated on the Drawings.
   2. Provide as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

B. Contactors:
   1. NEMA size as indicated on the Drawings.
   2. Electrically held:
      a. For lighting loads designed to withstand the initial inrush currents of ballast and lamp loads.
   3. Factory adjusted and chatter free.
   4. Auxiliary contacts:
      a. Contact ratings in accordance with NEMA A600 rating:
         1) Auxiliary contacts rated 10 amps at 600 volts.
      b. Provide contacts indicated on the Drawings and any additional contacts required for proper operation.
      c. Provide at least 1 normally open and 1 normally closed spare auxiliary contact.
   5. Constructed in accordance with the following standards:
      a. UL 508.
      b. IEC 947-4:
         1) Type 1 coordination when protected by a circuit breaker.
         2) Type 2 coordination when protected by a suitable UL listed fuse.
      c. IEC 801-1 parts 2 through 6.

C. Overloads:
   1. Solid state electronic:
      a. Selectable Class 10, 20, 30 protection.
      b. Ambient insensitive:
         1) Operating temperature: -20 to 70 degrees Celsius.
      c. Thermal memory.
      d. Protective functions:
         1) Motor overcurrent.
         2) Phase unbalance (adjustable).
         3) Phase loss.
         4) Ground fault protection.
      e. Self-powered.
      f. Provide current transformers for metering of motor current.

g. Visible trip indicator.
h. Push-to-trip test.
i. Isolated normally open alarm contact.
j. Normally closed trip contact.
k. Manual reset.

D. Control power transformer:
1. Furnish integral control power transformer capacity to power:
a. Motor controls: Motor and starter accessories indicated on the Drawings or specified.
2. Primary and secondary fusing as indicated on the Drawings:
a. Fusing sized by the manufacturer for the rating of the transformer furnished.
3. Control power transformer secondary voltage:
a. As indicated on the Drawings.

2.06 ACCESSORIES

A. Lugs and terminals:
1. For external connections of No. 6 AWG and larger.
2. UL listed for either copper or aluminum conductors.

B. Surge protective devices:
1. Furnish surge protection devices across the coil of each starter, contactor, and relay.

C. Pilot devices:
1. Provide pilot lights, switches, elapsed time meters, and other devices as specified or as indicated on the Drawings.
2. As specified in Section 40_67_01 - Control Systems: Panels, Enclosures, and Panel Components.

D. Nameplates and wire markers:
1. As specified in Section 26_05_53 - Identification for Electrical Systems.

E. Conformal coating:
1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as H_2S and chlorine.

2.07 SOURCE QUALITY CONTROL

A. Source Testing:
1. Furnish test reports and Manufacturer’s Certificate of Source Testing.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Starters in motor control centers:
   1. As specified in Section 26_24_20 - Low Voltage Motor Control Centers.

C. Starters in control panels:
   1. As specified in Section 40_67_01 - Control Systems: Panels, Enclosures, and Panel Components.

3.03 FIELD QUALITY CONTROL

A. Field electrical acceptance testing:
   1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

3.04 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations: 2.
      b. Maintenance: 2.

3.05 ADJUSTING

A. Make adjustments as necessary and as recommended by the manufacturer, Engineer, or testing firm.

B. Set overloads and motor circuit protectors based on the nameplate values of the installed motor.

END OF SECTION

SECTION 26_29_24

VARIABLE FREQUENCY DRIVES 0.50 - 50 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Variable frequency drives (VFD) 0.5 to 50 horsepower for control of NEMA Design B squirrel cage induction motors.

1.02 REFERENCES

A. International Organization for Standardization (ISO):
   1. 9001 - Quality Management Systems - Requirements.

B. National Electrical Manufacturers Association (NEMA).

C. Underwriters Laboratories (UL):
   1. 508A - Standard for Safety for Industrial Control Panels.
   2. 845 - Standard for Motor Control Centers.
   3. 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Point of common coupling: The point of common coupling for all harmonic calculation and field measurements for both voltage and current distortions is defined as the closest directly connected bus supplying power to the VFD.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures:
   1. Custom prepared by the VFD manufacturer and specific for the equipment furnished.

B. Product data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.

c. Depth.
d. Weight.

4. Nameplate schedule.
5. Bill of material.
6. Ratings:
   a. Voltage.
   b. Phase.
   c. Input current.
   d. Output current.
   e. Interrupting rating.
   f. Momentary current rating.
7. List of recommended spare parts.
8. Catalog cutsheets for major components.
9. Design data:
   a. Efficiency and power factor values.
   b. Certification that the drive is sized for the full nameplate motor horsepower and current of the driven load at the installed altitude and ambient temperature.
   c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
   d. Certification that electronic circuits and printed circuit boards are conformally coated.
10. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01_81_50 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
   1. Complete plan and elevation drawings showing:
      a. Dimensions.
      b. Panel, sub-panel, and component layout indexed to the bill of material.
      c. Conduit connections.
   2. Block diagram showing the basic control and protection systems specifying the protection, control, trip and alarm functions, the reference signals and commands and the auxiliary devices.
   3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
      a. Include terminal number and wire numbers.
   4. Complete single-line and 3-line diagrams, including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
      a. Clearly indicate device electrical ratings on the Drawings.

D. Delegated Design Submittals:
    1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria:
        a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
        b. For equipment installed outdoors.
        c. For wall mounted equipment weighing 125 pounds or more.

E. Installation instructions:
    1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
    2. Provide manufacturer's installation instructions.

F. Quality Control Submittals:
    1. Manufacturer's representative qualifications.
    2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
    3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
    4. Test reports.
    5. Report listing the setting of VFD adjustable parameters and their values after start-up.

G. Owner Training Submittals:
    1. As specified in Section 01_75_17 - Commissioning.

H. Operation and maintenance manuals:
    1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
    2. Spare parts list with supplier names and part numbers.
    3. Startup and commissioning instructions and data.
    4. Operating manuals:
        a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
    5. Operating instructions:
        a. Written descriptions detailing the operational functions of controls on the front panel.
    6. Maintenance manual:
        a. Furnish maintenance manuals with instructions covering details pertaining to care and maintenance of equipment as well as identifying all parts.
        b. Manuals shall include, but are not limited to, the following:
            1) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
            2) Detailed control instructions which outline the purpose and operation of every control device used in normal operation.
            3) Schematic wiring and external diagrams:
                a) Furnish Drawings in a reduced 11-inch by 17-inch format that are fully legible at that size.

I. Test forms and reports:
   1. Submit complete factory acceptance test procedures and forms used during the test.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Any third-party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
   2. VFDs shall be UL 61800-5-1 listed and labeled:
      a. UL 61800-5-1 for individual units.
      b. UL 508A for VFD systems in control panels.
      c. UL 845 for VFD systems in motor control centers.
   3. VFDs shall be manufactured by the VFD manufacturer at its own facility which shall have a quality assurance program certified in accordance with ISO 9001.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the VFDs and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on-site off-loading equipment:
   1. VFDs shall be delivered to the Site preassembled and wired.

B. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct factory acceptance test and submit certified test results for the Engineer’s review.
   2. Ship equipment to Project Site after successful completion of factory acceptance test.
   3. Assemble equipment in the field.
   4. Conduct field acceptance test and submit results for the Engineer’s review.
   5. Submit Manufacturers Certificate of Installation and Functionality Compliance.
   6. Conduct Owner Training sessions.
   7. Commissioning and process start-up as specified in Section 01_75_17 - Commissioning.

1.10 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.11 SYSTEM START-UP

A. VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer, and Owner.

1.12 MAINTENANCE

A. Spare parts:
   1. The following shall be furnished:
      a. 1 set of power and control fuses for each VFD.
      b. 1 complete main control keypad for each type and rated size of VFD.
      c. 1 spare fan for each VFD unit.
      d. 2 sets of ventilation filters for each VFD unit (if applicable in VFD cabinet louvers).
      e. 1 set of thyristors or power electronics for each type and rated size of VFD.
      f. Any special dedicated tools for emergency service and troubleshooting.
      g. Hardware and software required for configuration, maintenance, troubleshooting, and inquiry of drive parameters.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer’s specified operating ranges.

D. Design requirements:
   1. Each VFD system consists of components required to meet the performance, protection, safety, testing, and certification criteria of this Section.
   2. VFD system:
      a. Is a fully integrated package.
      b. Includes material necessary to interconnect VFD system elements, even if shipped separately.
   3. Coordinate bearing protection methods with the supplier of the driven equipment.

E. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer:
   1. Each VFD shall be completely factory pre-wired, assembled, and then tested as a complete system by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.
   2. VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics based upon the installed conditions:
      a. Provide equipment necessary to mitigate potential damage to motor insulation.
      b. Motors as specified in Section 26_05_09 - Low Voltage Motors up to 500 hp.

F. Performance:
   1. Operating envelope:
      a. Speed and torque requirements:
         1) Provide a variable torque or constant torque VFD as required by the driven load.
         2) VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 200 percent (25 to 120 hertz) speed range.
      b. Current requirements:
         1) Full rated current output on a continuous basis.
         2) Variable torque VFD:
            a) Minimum 110 percent current overload for 1 minute.
         3) Constant torque VFD:
            a) Minimum 150 percent current overload for 1 minute.
   2. Minimum VFD system efficiency:
      a. 96 percent when operating at the rated kW output.
      b. VFD system efficiency shall be calculated as follows:

$$\textit{Efficiency (\%)} = \frac{\textit{Power (Load)}}{\textit{Power (Supply)}} \textit{ X 100}$$

         1) Power (Load) is the total power measured at the output terminals of the drive system, including VFD, output filters, or transformers.
         2) Power (Supply) is the total power measured at the input terminals of the VFD, including input filters, line reactors, isolation transformers, harmonic distortion attenuation equipment and auxiliary equipment (e.g., controls, fans) for complete system operation.
   3. Total power factor:
      a. Minimum of 0.96 lagging across the entire speed range.
      b. At no speed shall the VFD have a leading power factor.
   4. Frequency accuracy:
      a. Minimum of within 0.01 percent.
   5. Speed regulation:
      a. Minimum of within 0.5 percent across the entire speed range.

2.02 MANUFACTURERS

A. One of the following or equal:
   1. ABB.

2. Allen-Bradley.
3. Danfoss VLT/Vacon.
4. Eaton.
5. Schneider Electric.
6. Siemens-Robicon.

2.03 EQUIPMENT

A. General:
1. Sinusoidal pulse width modulated (PWM) type drive.
a. 6-pulse insulated gate bipolar transistor (IGBT) power section.
b. Microprocessor based controls.
c. Line reactor and output device as specified in this Section.

B. Ratings:
1. Voltage:
a. Input voltage as indicated on the Drawings.

C. Operational features:
1. Protective features:
a. Provide the following minimum protective features:
1) Motor overload protection.
2) Instantaneous overcurrent.
3) Instantaneous overvoltage.
4) Undervoltage.
5) Power unit overtemperature.
6) Phase loss.
7) VFD output short circuit.
2. Control mode:
a. Operation in either a constant volts/hertz or sensorless vector mode:
1) Control mode selectable using the programming keypad.
3. Frequency control:
a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
b. Programmable minimum frequency.
c. Programmable maximum frequency.
4. Acceleration/deceleration:
a. Separately adjustable acceleration and deceleration rates:
1) Each rate adjustable from 0.01 to 1,800 seconds.
5. Spinning load:
a. VFD shall be capable of determining the speed and direction of a spinning load, “catch” the load and accelerate or decelerate it without damage to the load.
6. Programmable loss of signal:
a. Upon loss of speed reference, the VFD shall be programmable to either:
1) Stop.
2) Maintain current speed.
3) Default to pre-selected speed.
7. Power interrupt ride-through:
a. VFD shall be capable of continuous operation in the event of a power loss of 5 cycles or less.

8. Inputs/outputs:
    a. Manufacturer's standard number the following:
        1) Analog inputs:
            a) Configurable as either 0 to 10 V or 4 to 20 mA.
        2) Analog outputs:
            a) Programmable 4 to 20 mA isolated.
        3) Discrete inputs:
            a) Programmable.
        4) Discrete outputs:
            a) Programmable.
            b) Form C relay contacts.
        5) Potentiometer 3-wire input.
    b. Provide additional inputs/outputs as required to meet the control functions indicated on the Drawings.
9. Communications:
    a. Provide each VFD with a Modbus TCP communications interface module.
    b. Use of gateways is not acceptable.
    c. Protocols shall be certified by the governing authority.
10. Diagnostics:
    a. Store a minimum of 4 fault conditions in non-volatile memory on a first in-first out basis.
    b. Operational parameters stored at the time of the fault:
        1) Operating frequency.
        2) Drive status.
        3) Power mode.
    c. Fault memory accessible via RS-232, RS-422, or RS-485.
11. Automatic restart:
    a. User selectable automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
        1) Programmable for up to 9 restart attempts.
        2) Adjustable time delay between restart attempts.

2.04 COMPONENTS

A. Enclosure:
    1. NEMA Type 12, 4X 316 Stainless Steel, or motor control center as indicated on the Drawings.
    2. Provide cooling devices required to maintain the VFD within the manufacturer's specified temperature limits for the Project conditions:
        a. Provide cooling device failure alarm.

B. Power disconnect:
    1. Flange-mounted thermal magnetic circuit breaker.
    2. Lockable in the OFF position.

C. Input reactor:
    1. 3 percent input line reactor.

D. Output device as indicated on the Drawings:
    1. 3 percent output load reactor.

2. dv/dt filter:
    a. Common mode reduction: 30 percent minimum.
    b. Motor terminal peak voltage limit: 150 percent of DC bus voltage with a motor lead length up to 1,000 feet.
    c. Carrier frequency range: Up to 12 kHz.
    d. Efficiency: 98 percent minimum.
    e. Class H insulation minimum.

E. Keypad:
1. Provide each VFD with a keypad for programming and control.
2. Keypad requirements:
    a. Password security to protect drive parameters.
    b. Mounted on the door of the VFD enclosure.
    c. Back-lit LCD:
        1) Minimum of 2 lines with a minimum of 16 characters per line.
    d. Programming and display features language: English.
    e. Capable of displaying the following parameters:
        1) Speed (percent).
        2) Output current (amperes).
        3) Output frequency (hertz).
        4) Input voltage.
        5) Output voltage.
        6) Total 3-phase kilowatt.
        7) Kilowatt-hour meter.
        8) Elapsed run time meter.
        9) Revolutions per minute.
        10) Direct current bus voltage.
3. In addition to keys required for programming, provide the following controls on the keypad:
    a. Auto/manual selector.
    b. Start pushbutton.
    c. Stop pushbutton.
    d. Jog pushbutton.
    e. Speed increment.
    f. Speed decrement.
    g. Forward/reverse selector.
    h. Run LED indicator.
    i. Program LED indicator.
    j. Fault LED indicator.
4. Provide the VFD with the hardwired controls as indicated on the Drawings.

F. Control power transformer:
1. Furnish a control power transformer mounted and wired inside the VFD enclosure.
2. With primary and secondary fusing.
3. Sized to power VFD controls and options as well as any external devices indicated on the Drawings, including the motor winding heater.

2.05 ACCESSORIES

A. Metal oxide varistors:
   1. Provide protection for the VFD against:
      a. Line transients: 5,000-volt peak minimum.
      b. Line to ground transients: 7,000-volt peak minimum.

B. Conformal coating:
   1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as a protection against moisture, dust, temperature extremes, and chemicals such as H_2S and chlorine.

2.06 FINISHES

A. Enclosure finish shall be manufacturer's standard gray.

2.07 SOURCE QUALITY CONTROL

A. Source Testing (Factory Acceptance Tests):
   1. Witnessed, virtual only.
   2. General:
      a. Incoming inspection of components and raw materials based on strategic supplier base and experience.
      b. VFDs furnished under this Section shall be tested and inspected as specified below. Testing of VFDs based on sampling plans is not allowed.
      c. Testing procedures specified are the minimum acceptable requirements. Manufacturer may perform additional tests at its discretion.
   3. Failure of any component during testing requires repair of the faulted component and complete retest.
   4. Perform manufacturer's standard factory acceptance tests.
   5. Furnish test reports and Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish cables, conduit, lugs, bolts, and other accessories needed to complete the installation of the VFD (free-standing or within motor control center).

2. Assemble and install the VFD in the locations and with the layouts indicated on the Drawings.
3. Perform Work in accordance with the manufacturer's instructions and Shop Drawings.
4. Furnish components and equipment as required to complete the installation.
5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
6. Install free-standing enclosures on a raised concrete housekeeping pad:
    a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
    b. Weld and/or bolt the VFD frame to the leveling channels.
7. Provide openings in top or bottom of the VFD (free-standing or within motor control center) enclosure for conduit only, no additional openings will be allowed:
    a. Improperly cut holes will require that the entire panel be replaced:
        1) No hole closers or patches will be allowed.
8. Bundle circuits together and terminate in each unit:
    a. Tie with nylon wire ties.
    b. Label wires at each end with wire numbers shown on the approved control drawings.
    c. Connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

C. Furnish Manufacturer's Certificate of Installation Verification.

3.03 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

C. Provide the services of a VFD manufacturer representative for startup assistance:
1. Inspection and field adjustment:
    a. Supervise the following and submit written certification that the equipment and controls have been properly installed, aligned, adjusted, and readied for operation.
2. Startup field testing:
    a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
    b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.

3.04 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
1. Number of sessions:
    a. Operations: 2.
    b. Maintenance: 2.

3.05 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Provide the services of a VFD manufacturer factory technician to make drive parameters and protective device settings:
   1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
   2. Provide documentation of VFD settings, including, but not limited to:
      a. Minimum speed.
      b. Maximum speed.
      c. Skip speeds.
      d. Current limit.
      e. Acceleration time.
      f. Deceleration time.

END OF SECTION

SECTION 26_36_24

TRANSFER SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Transfer switches.

1.02 REFERENCES

A. Abbreviations:
   1. ATS: Automatic transfer switch.
   2. MTS: Manually initiated, electrically operated transfer switch.

B. Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. Underwriters Laboratories (UL):
      a. 1008 - Transfer Switch Equipment.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. SCCR: Short-circuit current rating, the maximum short-circuit current a component and assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.
   2. WCR: Withstand and closing rating, represents a transfer switch's capability to ride out a fault condition until the overcurrent protective device opens and clears the fault.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Manufacturer of transfer switch.
   2. Manufacturer of component parts of the ATS.
   3. Dimensions:
      a. Width.
      b. Length.

c. Height.
d. Weight.

4. Bill of material.
5. Description of operation.
6. Ratings:
   a. Voltage.
   b. Phase.
   c. Current.
   d. Number of poles.
   e. Withstand and closing rating (WCR).
7. List of recommended spare parts.
8. For equipment installed in structures designated as Seismic Design Category C, D, E, or F, submit the following as specified in Section 01_81_50 - Design Criteria:
   a. Manufacturer’s statement of seismic qualification with substantiating test data.
   b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop Drawings:
1. Layout drawings:
   a. Furnish full-dimension and to-scale equipment layout drawings, which include:
      1) Plan, front, and side views.
      2) Sub-panels.
      3) Interior panels.
      4) Top and bottom conduit windows.
2. Complete electrical wiring diagrams:
   a. Point-to-point connections.
   b. Indicate wire numbers.
3. Complete interface and connection diagrams.
4. Transfer equipment label indicating the short-circuit current rating (SCCR).

D. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the transfer switch to prove the transfer switch is suitable for the seismic requirements at the Project Site.

E. Delegated Design Submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria:
   a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
   b. For equipment installed outdoors.
   c. For wall mounted equipment weighing 125 pounds or more.

F. Installation instructions:
1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
2. Provide manufacturer’s installation instructions.

G. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
   3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
   4. Test reports.

H. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

I. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
   2. Operating instructions:
      a. Printed and framed instruction chart suitable for wall hanging.
      b. Detail the operational functions of transfer switch controls.
   3. Maintenance manual:
      a. Furnish maintenance manuals with instructions covering maintenance of equipment and data identifying all parts.
      b. Furnish information needed to maintain the transfer switch, including, but not limited to, the following:
         1) Instructions for testing, adjustment, and start-up.
         2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
         3) Description of the sequence of operation that outlines the steps that follow normal power failure, transfer to standby power, return to normal power, and fault conditions.
         4) Schematics and wiring:
            a) Furnished in a reduced 11-inch-by-17-inch fully legible format.
         5) Report listing the installed setting of adjustable parameters for the automatic transfer system.

1.06 QUALITY ASSURANCE

A. Where indicated on the Drawings, the transfer switch shall be UL labeled and listed "Suitable for Service Entrance".

1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the transfer switch to the job site on a dedicated air-ride vehicle that will allow the Contractor to utilize on-site off-loading equipment.

B. Furnish temporary equipment heaters within the transfer switch to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.09 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide transfer switches capable of transferring load circuits from utility power to standby power and back.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. ATS sequence of operation for open transition:
   1. When the voltage of any normal source phase drops below 80 percent and after an adjustable time delay (0 to 6 seconds minimum), the transfer switch shall initiate normal source fail alarm and prepare to transfer to standby source.
   2. When standby voltage reaches 90 percent of nominal, and frequency is within 2 hertz of nominal, following an adjustable time delay (0 to 10 seconds), the switch shall transfer to standby source.
   3. When normal power source has been restored to 90 percent of nominal on all phases, following an adjustable time delay (0 to 30 minutes), the switch shall retransfer to normal power:
      a. If the standby source fails during this time delay, the switch shall automatically retransfer to normal source.
         1) This functionality shall be configurable to disable automatic retransfer via operator-initiated retransfer.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. ASCO.
   3. Eaton.
   4. Russelectric, Inc.

2.04 EQUIPMENT

A. General:
   1. Capable of switching all classes of load.
   2. Rated for continuous duty when installed in a non-ventilated enclosure.
   3. Provide circuit breakers or contactors rated for continuous duty.
   4. Minimum transfer time for delayed transition ATS: 1 second.
   5. Capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.
   6. Provide automatic transfer switches with provisions for manual operation under no load.
   7. Transfer switch short circuit rating to be coordinated with the overcurrent protective devices at the fault current available on the line side of the transfer switch.

B. Electrical ratings:
   1. Voltage, configuration, and amp ratings as indicated on the Drawings.
   2. WCR in accordance with UL 1008.

C. Contacts:
   1. Mechanically held.
   2. Mechanically interlocked to prevent normal and standby sources from being closed at the same time.
   3. Silver alloy construction.
   4. Neutral contact, when indicated on the Drawings:
      a. Same ratings as the phase contacts.
      b. Break last and make first operation.

D. Controls:
   1. ATS shall have 3-phase over-voltage, under-voltage, over-frequency, and under-frequency on both normal and standby sources.
   2. Control panel:
      a. Microprocessor based.
      b. 4-line, 20-character LCD display. Displayed data shall include:
         1) Normal and standby source parameters.
         2) Diagnostic information.
         3) Switch and timer status.
      c. Keypad for making ATS settings and operating parameters:
         1) Settings shall be password protected.
      d. LED display of the following:
         1) Normal source available.
         2) Connected to normal source.
         3) Standby source available.
         4) Connected to standby source.
      e. Communications: Modbus TCP.
      f. Provisions for testing ATS operation by simulating a normal source failure.
   3. Status and control contacts:
      a. Generator start/stop contact:
         1) Single-pole, double-throw.
         2) Rated for 5 amps at 30 VDC.

b. Status contacts:
    1) Single-pole, double-throw.
    2) Rated for 10 amps at 250 VAC.
    3) Provide contacts for the following:
        a) ATS Bypass.
        b) ATS Fail.
        c) Normal source available.
        d) Normal source failure.
        e) Connected to normal source.
        f) Standby source available.
        g) Standby source failure.
        h) Connected to standby source.

E. Enclosure:
    1. NEMA 12.

F. Bypass-isolation switch:
    1. Provide a bypass-isolation transfer switch to allow electrical bypass and isolation of the ATS:
        a. Bypass of the load to either normal or standby source with complete isolation of the automatic transfer switch shall be possible.
        b. Load shall not be interrupted during bypass or isolation functions:
            1) Configurations that include load break contacts causing load interruption are not acceptable.
            2) Bypass-isolation contacts shall not be in the circuit, except during bypass-isolation operation.
        c. All operations shall be possible with the enclosure door closed.
    2. Isolation handle shall have 3 positions: Automatic, Test, and Isolate:
        a. Test position shall permit electrical testing of the automatic transfer switch without load interruption.
        b. Isolate position shall completely isolate the transfer switch from both sources and load without actual removal of the line or load conductors:
            1) Allows for removal of the transfer switch.
        c. While in the Test or Isolate positions, the bypass-isolation switch shall function as a manual transfer switch:
            1) Manual transfer shall be independent of the transfer switch position, including transfer switch removal.
            2) Reconnection of load terminals shall not be required.
        d. Operating speed of the bypass-isolation switch contacts shall be independent of the speed of the isolation handle.
    3. Furnished with a diagnostic instruction plate located on the enclosure door, including the following indication lights:
        a. Normal source available.
        b. Emergency source available.
        c. Bypass switch in normal position.
        d. Bypass switch in emergency position.
        e. Automatic transfer switch in Test position.
        f. Automatic transfer switch isolated.
        g. Automatic transfer switch inhibited.

h. Automatic transfer switch operator disconnect switch “OFF.”
i. Automatic transfer switch in normal position.
j. Automatic transfer switch in emergency position.

2.05 SOURCE QUALITY CONTROL

A. Source Testing:
1. Complete factory test to verify proper operation of timers, settings, and operation.
2. Furnish test reports and Manufacturer’s Certificate of Source Testing.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
2. Install anchors of type and material indicated on approved anchoring designs.
3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
1. Furnish components and equipment as required to complete the installation.
2. Replace hardware lost or damaged during the installation or handling to provide a complete installation.
3. Install the transfer switch on a raised concrete housekeeping pad:
a. Provide structural leveling channels in accordance with the manufacturer’s recommendations to provide proper alignment of the units.
b. Weld and/or bolt the transfer switch frame to the leveling channels.
4. Provide openings in top or bottom of the enclosure for conduit only, no additional openings will be allowed:
a. Improperly cut holes will require that the entire panel be replaced:
1) No hole closers or patches will be allowed.

C. Furnish Manufacturer’s Certificate of Installation Verification.

3.03 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

3.04 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations: 2.
      b. Maintenance: 2.

END OF SECTION

SECTION 26_43_10

ELECTRICAL SAFETY DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Absence of voltage detectors.
   2. Infrared (I/R) windows.

1.02 REFERENCES

A. Abbreviations:
   1. I/R: Infrared.

B. Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
      b. 70E - Standard for Electrical Safety in the Workplace.

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Manufacturer.
   2. Catalog cutsheets.
   3. Dimensions:
      a. Height.
      b. Length.
      c. Width.
      d. Weight.
   4. Nameplate schedule.
   5. Bill of material.
   6. Description of operation:
      a. Outlining function and operation of each device.
   7. Ratings:
      a. Voltage.
      b. Phase.
      c. Current.
      d. Interrupting rating (circuit breakers and fuses).

8. Enclosure information:
    a. NEMA rating.
    b. Materials.
9. List of recommended spare parts.
10. Manufacturer's recommended special tools for installation and maintenance, if required.

C. Installation instructions:
    1. Provide manufacturer's installation instructions.

D. Quality Control Submittals:
    1. Manufacturer's representative qualifications.
    2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
    3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
    4. Manufacturer's Certificate of Functional Compliance as specified in Section 01_75_17 - Commissioning.

E. Owner Training Submittals:
    1. As specified in Section 01_75_17 - Commissioning.

F. Operation and maintenance manuals:
    1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.

1.05 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Electrical safety devices designed, constructed, and tested in accordance with the reference standards in this Section.

2.02 MANUFACTURERS

A. I/R windows:
    1. One of the following or equal:
        a. Flir.
        b. Fluke.

B. Absence/presence of voltage detectors:
    1. One of the following or equal:
        a. Grace Engineering Products, Inc.
        b. I-Gard.
        c. Panduit.

2.03 EQUIPMENT

A. I/R windows:
   1. 4-inch diameter.
   2. Crystal lens infrared (IR) scanning window.
   3. Installed on each set of circuit breaker terminations, mounted on cable compartment door.

B. Absence and presence of voltage detectors:
   1. Voltage indicator with red LED lights to indicate the presence of voltage on each phase, neutral, and ground bus of the equipment.
   2. Sensor leads to monitor the bus. Tests do not pass if the sensors lose contact with the bus.
   3. Meets NFPA 70E requirement for absence of voltage testing.
   4. Installed on line side of main breaker and load side of main breaker.
   5. Displays mounted on enclosure of equipment. Clearly labeled verbally and graphically using mimic bus identifying where the detector is connected.

PART 3 EXECUTION

3.01 INSTALLATION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Install the equipment in accordance with the manufacturer installation instructions.

3.02 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations 2.
      b. Maintenance 2.

END OF SECTION

SECTION 26_43_14

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. High-energy surge protective devices.

1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits.
   2. C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and Less) AC Power Circuits.
   3. C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
   4. C62.62- Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1,000 V and less) AC Power Circuits.

B. International Electrotechnical Commission (IEC).

C. National Electrical Manufacturers Association (NEMA).

D. National Fire Protection Agency (NFPA):
   1. 20 - Standard for the Installation of Stationary Pumps for Fire Protection.
   2. 70 - National Electrical Code (NEC).
   3. 75 - Standard for the Fire Protection of Information Technology Equipment.
   4. 780 - Standard for the Installation of Lightning Protection Systems.

E. Underwriters Laboratory (UL):
   1. 96A - Standard for Installation Requirements for Lightning Protection Systems.
   2. 1283 - Standard for Electromagnetic Interference Filters.
   3. 1449 - Standard for Surge Protective Devices.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. I_n: Nominal discharge current.
   2. MCOV: Maximum continuous operating voltage.
   3. MOV: Metal oxide varistor.
   4. SAD: Silicon avalanche diode.
   5. SCCR: Short circuit current rating.

6. SPD: Surge protective device.
7. VPR: Voltage protection rating.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
   2. Manufacturer's catalog cutsheets indicating:
      a. Manufacturer and model numbers.
      b. Ratings of each SPD, including, but not limited to:
         1) Short circuit current rating.
         2) Nominal discharge current.
         3) Maximum continuous operating voltage.
         4) Voltage protection rating.
         5) System voltage.
         6) System frequency.
         7) Surge current capacity.
   3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
      a. Overcurrent protection.
      b. UL 1449.

C. Shop Drawings:
   1. Provide electrical and mechanical drawings by the manufacturer that detail:
      a. Unit dimensions.
      b. Weights.
      c. Components.
      d. Field connection locations.
      e. Mounting provisions.
      f. Connection details.
      g. Wiring diagram.

D. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.

E. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

F. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
   2. Provide the manufacturer's manual with installation, start-up, and operating instructions for the specified system.

1.05 QUALITY ASSURANCE

A. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:
   1. IEEE C62.41.1, C62.41.2, C62.45, C62.62.
   2. Federal Information Processing Standards Publication 94 (FIBS PUB 94).
   3. NEMA.
   4. NFPA 20, 70, 75, and 780.
   5. UL 1449 current edition and UL 1283.

B. IEC 801.

C. Provide surge protective devices that are suitable for application in IEEE C62.41.1, C62.41.2 Category A, B, and C3 environments, as tested to IEEE C62.45.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

B. Extended warranty:
   1. Furnish a manufacturer's standard parts and labor warranty from date of shipment against any part failure when installed in compliance with the manufacturer's written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
   2. Warranty shall include:
      a. Direct, factory trained employees must be available within 48 hours for assessment of the problem.
      b. A 24-hour toll-free 800-number for warranty support.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide surge protection as indicated on the Drawings.

2.02 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.

3. Southern Tier Technologies.
4. Schneider Electric.

2.03 EQUIPMENT

A. Provide Type 1 or Type 2 SPD units as required for the locations indicated on the Drawings.

B. Electrical requirements:
   1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
   2. MCOV:
      a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
   3. Operating frequency:
      a. 47 to 63 hertz.
   4. SCCR:
      a. 65 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
      b. Marked on the SPD in accordance with UL 1449 and the NEC.
   5. Nominal discharge current I_n:
      a. 20 kA.
   6. Maximum VPR:

Modes	240/120 3W	208Y/120	480Y/277	480 V
L-N, L-G, N-G	700	700	1,200	1,800
L-L	1,200	1,200	2,000	1,800

   7. Peak surge current:
      a. Service entrance locations:
         1) 240 kA per phase minimum.
         2) 120 kA per mode minimum.
      b. Branch locations:
         1) 120 kA per phase, minimum.
         2) 60 kA per mode minimum.

C. Protection modes:
   1. Provide SPD protection modes as follows:
      a. Line to Neutral (L-N) where applicable.
      b. Line to Ground (L-G).
      c. Neutral to Ground (N-G), where applicable.

D. Environmental requirements:
   1. Storage temperature:
      a. -40 to 122 degrees Fahrenheit.
   2. Operating temperature:
      a. 32 to 140 degrees Fahrenheit.
   3. Relative humidity:
      a. 5 to 95 percent.

4. Audible noise:
    a. Less than 45 dBa at 5 feet (1.5 m).
5. Operating altitude:
    a. Zero to 12,000 feet above sea level.

2.04 COMPONENTS

A. Enclosure:
    1. Located in electrical equipment as indicated on the Drawings.

B. Internal connections:
    1. Provide low impedance copper plates for intra-unit connections:
        a. Attach surge modules using bolted connections to the plates for low impedance connections.
    2. Size connections, conductors, and terminals for the specified surge current capacity.

C. Surge diversion modules:
    1. MOV:
        a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer's defects.

D. Overcurrent protection:
    1. Individually fuse components, including suppression, filtering, and monitoring components:
        a. Rated to allow maximum specified nominal discharge current capacity.
        b. Overcurrent protection that limits specified surge currents is not acceptable.

E. Connections:
    1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.05 ACCESSORIES

A. Unit status indicators:
    1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
        a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
        b. Indicates the status of protection on each mode or phase.

B. Dry contacts for remote monitoring:
    1. Electrically isolated Form C dry contacts (1 A/125 VAC, or 2 A/24 VDC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.

C. Provide an audible alarm which activates under any fault condition:
    1. Alarm On/Off switch to silence the alarm.
    2. A visible LED will confirm whether alarm is On or Disabled.
    3. Locate both switches and the audible alarm on the unit's front cover.

D. Provide transient counter to count transient voltage surges:
   1. LCD readout located on the unit's front cover.
   2. Counter to utilize batteries with a 10-year nominal life or non-volatile memory to maintain accurate counts in the event of power loss.

2.06 SOURCE QUALITY CONTROL

A. Source Testing:
   1. Perform manufacturer's standard factory test:
      a. Perform testing in accordance with UL 1449.
   2. Furnish test reports and Manufacturer's Certificate of Source Testing.

B. Permanently affix surge rating to the SPD.

PART 3 EXECUTION

3.01 INSTALLATION

A. Follow the manufacturer's recommended installation practices and comply with all applicable codes.

B. Special techniques:
   1. Install SPDs internal to equipment with as short and straight conductors, including ground conductor as practically possible:
      a. Twist the input conductors together to reduce input conductor inductance.
   2. Do not subject SPD to insulation resistance testing.

3.02 FIELD QUALITY CONTROL

A. Field electrical acceptance testing:
   1. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

3.03 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations 2.
      b. Maintenance 2.

END OF SECTION

SECTION 26_50_10

LIGHTING: LED LUMINAIRES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. LED luminaires, drivers, poles, and accessories.

1.02 REFERENCES

A. Illuminating Engineering Society (IES):
   1. LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products.
   2. LM-80 - Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
   3. RP-7 - Recommended Practice for Lighting Industrial Facilities.
   4. TM-21 - Projecting Long Term Lumen, Photon, and Radiant Flux Maintenance of LED Light Sources.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

C. National Electrical Manufacturers Association (NEMA):
   1. 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.

D. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

E. Underwriters Laboratories (UL):
   1. 1598 - Luminaires.
   2. 8750 - Light Emitting Diode (LED) Equipment for Use In Lighting Products.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. CCT (correlated color temperature) - Scientific scale to describe how “warm” or how “cool” the light source is, measured in Kelvin. The lower the Kelvin temperature, the warmer the light feels, or appears.
   2. CRI (color rendering index) - A quantitative measure of the ability of a light source to reveal the colors of various objects faithfully in comparison with an ideal or natural light source.
   3. Driver - Device that manages power and controls the current flow from AC to DC for an LED lighting product.

4. Efficacy - Lumen output of a light source per unit of power supplied to that source (lumens per watt).
5. EMI (electromagnetic interference) - Electrical interference (noise) generated by electrical and electronic devices.
6. FC (foot candles) - Measure of light level on a surface being illuminated.
7. L70 - Extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from initial values.
8. LED (light emitting diode) - A solid-state semiconductor device that produces light when electrical current flows through it.
9. LED light source - See LED luminaire.
10. LED luminaire - A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit.
11. Lumen - International (SI) unit of luminous flux or quantity of light. The amount of light that is spread over a square foot of surface by 1 candle power when all parts of the surface are exactly 1 foot from the light source.
12. Lumen ambient temperature multiplier - LED light source relative lumen output when compared to a standard ambient temperature.
13. Lumen maintenance factor - How well an LED light source is able to retain its intensity when compared to new.
14. Luminaire - Lighting unit.
15. THD (total harmonic distortion) - Combined effect of harmonic Distortion on the AC waveform produced by a driver or other device.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing for light poles.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. LED luminaires:
      a. Catalog literature for each luminaire specified, cross-referenced to the luminaire type on the Luminaire Schedule, in the Drawings.
      b. Provide for each luminaire type:
         1) Materials.
         2) Type of diffuser.
         3) Hardware.
         4) Gasketing.
         5) Reflector.
         6) Chassis.
         7) Finish and color.
         8) Driver type and protection.
         9) LED luminaire:
            a) Initial lumen output at 40 degrees Celsius ambient.
            b) Correlated color temperature.

c) Lumen maintenance factors.
d) Lumen ambient temperature multipliers.
e) Drive current.
f) Efficacy.

10) Picture of luminaire.
11) IES optical distributions.
12) Dimensioned drawings:
    a) Effective projected area rating for pole mounted luminaires.
13) Weight.
14) Photometric data:
    a) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
    b) Luminaire dirt depreciation factor.
    c) Candlepower distribution curves.
    d) Average luminaire brightness.
    e) Lumen output charts.
15) Furnish support method for interior luminaires weighing more than 30 pounds and all wall-mounted luminaires:
    a) Support methods shall be based on seismic requirements at the Project Site as specified in Section 01_81_50 - Design Criteria.

c. Luminaire substitutions:
    1) Provide complete literature for each luminaire substitution:
    2) Submittals for substituted luminaires shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire:
        a) Photometric data:
            (1) IES file in standard IES format.
            (2) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
            (3) Candlepower distribution curves.
            (4) Average luminaire brightness.
            (5) Lumen output charts.
            (6) Power requirements in watts and volt-amperes.
        b) Calculations:
            (1) Provide software generated calculations showing illuminance levels in footcandles and power usage in watts per square foot for each of the areas in which substitutions are proposed:
                (a) Use surface reflectance values in accordance with IES RP-7.
                (b) Use manufacturer projected lumen maintenance factor for minimum of 60,000 hours to perform all calculations.
        c) Specification sheets:
            (1) If lacking sufficient detail to indicate compliance with Contract Documents, standard specification sheets will not be accepted. This includes, but is not limited to, luminaire type designation, manufacturer’s complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, L70 life rating, and any modifications necessary to meet the requirements of the Contract Documents.

3) Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance.
4) Substitutions shall comply with all applicable building and energy codes.

2. Driver: Provide for each driver type:
   a. Catalog number.
   b. Type of driver.
   c. Output wattage.
   d. Input voltage.
   e. Operating voltage range.
   f. Maximum input power.
   g. Efficiency.
   h. Operating line current.
   i. Power factor.
   j. Operating temperature range.
   k. Current output range in ambient temperatures of 30 to 55 degrees Celsius.
   l. Surge suppression data.
3. Photocell:
   a. Provide for each photocell type:
      1) Switching capacity.
      2) Life expectancy when used on LED sources.
      3) Means of adjusting the lighting pickup level.
      4) Enclosure type.
      5) Mounting method.
4. Luminaire poles:
   a. Submit complete data for each pole type including, but not limited to:
      1) Material.
      2) Finish and color.
      3) Handholes.
      4) Anchoring.
      5) Luminaire attachment methods and fittings.
      6) Pole height.
      7) Pole dimensions.
      8) Bolt hole circle layout and hardware.
      9) Accessories.
      10) Provide the EPA wind load rating.
      11) Installation instructions for rigging, moving and setting into place.

C. Delegated Design Submittals:
   1. Project-specific calculations with anchoring and bracing details based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria.

D. Record documents:
   1. Update the Luminaire Schedule in the Drawings to reflect the acceptable substitutions, after the substitution has been reviewed and accepted by the Engineer.

1.06 QUALITY ASSURANCE

A. Luminaires shall be UL listed and labeled.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Scheduling:
   1. Exterior and outdoor lighting system operation shall be demonstrated during the hours of darkness.
   2. Lighting demonstration shall occur within 2 weeks before substantial completion.

1.09 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

B. LED luminaire:
   1. 5-year warranty from the date of installation including material, workmanship, photometrics, driver, and LED modules.

1.10 MAINTENANCE

A. Furnish 1 complete spare LED luminaire, with driver, of each type used.

PART 2 PRODUCTS

2.01 GENERAL

A. Individual luminaire types are indicated on the Drawings and on the Luminaire Schedule.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide luminaires and accessories for all lighting systems, complete and operable, in accordance with the requirements of the Contract Documents.

2.03 MANUFACTURERS

A. Luminaires:
   1. The following or equal:
      a. As noted on the Luminaire Schedule.

B. Drivers:
   1. One of the following or equal:
      a. eldoLED.
      b. Philips Advance.
      c. Thomas Research.

C. Photo-electric cells:
   1. One of the following or equal:
      a. Cooper.
      b. Hubbell-Killark.
      c. Intermatic.
      d. Tork.

D. Substitutions:
   1. Lighting design and luminaire selection has been based upon the photometric data of the identified luminaire. It is the Contractor's responsibility to ensure and prove to the Engineer at time of Submittal the substitutions meet the quality and photometric requirements of the original design.

2.04 EQUIPMENT

A. LED luminaires:
   1. General:
      a. Pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
      b. Provide the luminaires furnished as indicated on the Luminaire Schedule in the Drawings:
         1) Specifications noted in this Section are an addition or supplement to the Luminaire Schedule.
      c. Individual LEDs connected such that a catastrophic loss or the failure of 1 LED will not result in the loss of the entire luminaire.
   2. Minimum ambient temperature range of 0 degrees Celsius to 40 degrees Celsius.
   3. Minimum rated life:
      a. Office areas: 70,000 hours when operated at 25 degrees Celsius.
      b. Process areas: 100,000 hours when operated at 40 degrees Celsius.
      c. Hazardous areas: 100,000 hours when operated at 40 degrees Celsius.
   4. Minimum efficacy of 70 lumens/watt.
      a. Hazardous areas: Minimum 60 lumens/watt.
   5. Minimum Color Rendering Index of 70.
   6. Tested according to IES LM-79 and LM-80.
   7. Lumen maintenance projection in accordance with IES TM-21.
   8. RoHS compliant.
   9. Integral driver.
   10. Suitable for dry, damp, or wet locations as indicated on the Drawings or on the Luminaire Schedule.
      a. Wet or damp locations: UL 1598 listed.
   11. Designed as a complete LED assembly. Retrofit LED lamps in luminaires not designed specifically for LED light sources shall not be used.
   12. Exterior/outdoor luminaires:
      a. Luminaires in combination with their mounting pole and bracket shall be capable of withstanding:
         1) Wind levels at the Project Site without damage.
         2) Seismic levels at the Project Site.
      b. Corrosion-resistant hardware and hinged doors or lens retainer.
      c. Luminaires furnished with integral photoelectrical control shall be of the luminaire manufacturer's standard design.

13. Luminaires in hazardous areas:
    a. In accordance with NEC Section 500 requirements.
    b. UL labeled and identified for hazardous area.
    c. Marking on Class I and II, Division 1 and 2 areas shall identify the applicable material classification group.
    d. Marking shall include the temperature class (T code).

B. Photo-electric cells:
    1. Weatherproof
    2. In Class I Division 2 locations:
        a. Rated for used in Class I Division 2, Groups A, B, C, D locations.
        b. Factory sealed
    3. Photoelectric cells for control of multiple luminaires:
        a. Self-contained.
        b. Provided with time-delay features.
        c. Sized to meet switching capacity of the circuit:
            1) Based on luminaire VA as indicated on the Drawings.
    4. Photoelectric cell for control of a single luminaire:
        a. Integral to the luminaire.

C. Luminaire control:
    1. Lighting control relays or contactors as specified in Section 26_29_05 - Motor Starters.

D. Drivers:
    1. Dimmable, with dimming signal protocol of 0-10 VDC or DALI.
    2. Input power source:
        a. As indicated on the Drawings.
    3. Drive current:
        a. As indicated in the Luminaire Schedule.
    4. Power factor: Greater than 0.90.
    5. Efficiency: Greater than 80 percent.
    6. Total harmonic distortion (THD) of the input current less than 20 percent.
    7. Rated life of 60,000 hours in an LED luminaire operated at an ambient temperature of 40 degrees Celsius.
    8. Minimum operating temperature of -40 degrees Celsius.
    9. Sound rating: Class A+ or quieter.
    10. UL listed Class 2 Outdoor in accordance with UL 8750.
    11. In accordance with IEEE C62.41 Category A for transient protection.
    12. Driver must limit inrush current:
        a. Meet or exceed NEMA 410 driver inrush standard:
            1) 230 amps per 10 amp load with a maximum of 106 amps squared-seconds at 120 V.
            2) 430 amps per 10 amp load with a maximum of 370 amps squared-seconds at 277 V.

2.05 COMPONENTS

A. Luminaire stanchions:
   1. One of the following or equal:
      a. Collapsible spring assist lowering stanchion:
         1) Factory sealed and pre-wired from base to luminaire mounting bracket.
         2) Fully vertically adjustable with spring assistance.
         3) Capable of being locked into any position along its operational length.
         4) NEMA Type 4.
         5) Manufacturer: Eaton.
      b. Swivel joint lowering stanchion:
         1) Mid-pole swivel joint, lockable in multiple positions, to allow the upper portion of the pole to be swiveled down parallel to the working surface.
         2) Manufacturer: Swivelpole.
   2. Base/mounting as required for the installation:
      a. Column/wall.
   3. Mounting brackets:
      a. As required for the installation.
   4. Fastening hardware:
      a. Stainless steel.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Special techniques:
   1. Support luminaires from structural elements capable of carrying the total weight.
   2. Install luminaires plumb and square with building and wall intersections:
      a. Suspend pendant-mounted luminaries that are mounted from sloping ceilings with ball hangers, unless otherwise indicated on the Drawings.
      b. Install luminaires in machinery rooms after machines have been installed, so as to ensure no conflict with machinery, piping, or ductwork.
   3. In all cases, coordinate luminaire locations with work of other trades to prevent obstruction of light from the fixtures:
      a. Locate bottom of luminaire approximately at the bottom of ductwork, unless otherwise specified or indicated on the Drawings.

4. Support luminaires weighing more than 25 pounds independently of the outlet box and the conduit.
5. Provide ceiling or pendent mounted luminaires with a safety chain connecting the lens, driver, and other components to the building structure.
6. Provide recessed luminaires with auxiliary safety supports attached directly to the building structure:
    a. Safety supports shall consist of number 12 AWG soft drawn galvanized wires.
7. Install luminaires in accordance with the architectural reflected ceiling drawings:
    a. Center luminaires on ceiling tiles unless otherwise indicated.
8. Support luminaires installed in suspended grid ceilings, independently of the grid:
    a. Provide seismic restraint clips for luminaires installed in suspended grid ceilings.
9. Provide luminaires equipped with battery backup with an additional unswitched conductor from the power source circuit designated on the Drawing. Wall switches shall be wired to switch luminaires on and off, while maintaining power to the backup batteries.

C. Luminaire poles:
1. Set poles on anchor bolts and secured with double nuts on each bolt.
2. Dry-pack the pole base, after the luminaire and pole has been leveled and plumbed.
3. Bond metal poles to the plant grounding system, utilizing a ground lug connection within the pole:
    a. Route ground conductor through pier and pole base sleeve using Schedule 40 PVC conduit.

3.03 ADJUSTING

A. Aim and verify exterior and outdoor luminaires alignment, during dark evening hours, as directed by the Owner or the Engineer.

3.04 CLEANING

A. Clean lenses, diffusers, and reflectors.

B. Refinish luminaires' trim, poles, and support brackets, where finish has been damaged.

C. Clean LED luminaires (new and old), used during construction for construction lighting, before substantial completion.

D. Clean and re-lamp existing fluorescent and HID luminaires used during construction for construction lighting, before substantial completion.

3.05 SCHEDULES

A. Refer to the Luminaire Schedule in the Drawings.

END OF SECTION

SECTION 26_60_01

BURIED GALVANIC ANODE CATHODIC PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Galvanic anode cathodic protection systems.
   2. Isolation
   3. Ductile iron pipe joint bonds.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B1.1 - Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms).
   2. B1.20.1 - Pipe Threads, General Purpose, Inch.

B. American Water Works Association (AWWA):
   1. C217 - Petrolatum and Petrolatum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.

C. Association for Materials Protection and Performance (AMPP) (formerly NACE):
   1. SP0169 - Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
   2. SP0286 - Electrical Isolation of Cathodically Protected Pipelines.
   3. TM0497 - Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems.

D. ASTM International (ASTM):
   1. B3 - Soft or Annealed Copper Wire.
   2. B843- Magnesium Alloy Anodes for Cathodic Protection.
   3. C33/C33M - Concrete Aggregates.
   4. C94 - Ready-Mixed Concrete.
   5. D1248 - Polyethylene Plastics Extrusion Materials for Conductor and Cable.
   6. F436 - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
   7. G193 - Standard Terminology and Acronyms Relating to Corrosion.

E. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

F. NSF International (NSF):
   1. 61/600 - Drinking Water System Components - Health Effects.

G. Underwriters Laboratories, Inc. (UL).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Bonded dielectric coating: Protective barrier coating system with high electrical resistivity bonded directly to underlying structure, acting to physically and electrically isolate metallic structure from electrolyte.
   2. Cathodic protection:
      a. Galvanic anode cathodic protection: Reduction of corrosion of metal in electrolyte by galvanically coupling to more anodic metal:
         1) Also referred to as sacrificial or passive protection.
      b. Impressed current cathodic protection: Reduction of corrosion of metal in electrolyte by supplying DC current through external power source and employing impressed current anode.
         1) Also referred to as active protection.
   3. Electrical isolation: The condition of being electrically separate from other metallic structures (including, but not limited to, piping, reinforcement, casings) and the environment as defined in NACE SP0169.
   4. Electrically continuous: A structure which has a linear electrical resistance equal to or less than the sum of the resistance of the structure plus the maximum allowable joint bond resistance for each bonded joint as specified in this Section.
   5. Electrolyte: Electrically conductive solution, such as soil or water:
      a. Terms for specific conductive solutions may be substituted for “electrolyte” in these definitions:
         1) Conductive solutions include:
            a) Water.
            b) Soil.
            c) Concrete.
            d) Other conductive liquid medium.
   6. Foreign structure: Buried structure not owned or operated by the Owner.
   7. Reference electrode: Electrode whose open circuit potential is constant under similar conditions of measurement; used for measuring relative potentials of other electrodes (e.g., protected structures):
      a. Sometimes referred to as reference half-cell.
      b. Copper-copper sulfate reference electrode (CSE) is often used.
   8. Structure-to-electrolyte potential:
      a. Potential of structure in electrolyte as compared to potential of reference electrode contacting same electrolyte.
      b. Static: Determined without any external current:
         1) For instance: Prior to energizing cathodic protection system, and with no galvanic couple, pH cell, interference currents, or like present, or,
         2) After such current source has been disconnected for an extended amount of time.
         3) Also referred to as native.
      c. Uncorrected: Determined with cathodic protection system energized and cathodic protection current flowing:
         1) Also referred to as protective potential (ON potential) and may contain significant IR drop error.
      d. Polarized: Determined after cathodic protection system has been energized, but immediately after cathodic protection current is interrupted:
         1) Also referred to as “instant off” structure-to-electrolyte potential.

e. Polarization: Change from static or native potential as result of current flow across electrode/electrolyte interface:
    1) Also considered difference between polarized and native potentials.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Qualifications:
1. Cathodic protection technologist (NACE CP3) or cathodic protection specialist (NACE CP4) certifications for personnel conducting or directing testing and installation work.
    a. Include list of verifiable experience with corrosion monitoring and cathodic protection.

C. Product data:
1. Include as a minimum:
    a. Galvanic anodes.
    b. Test station.
    c. Shunts.
    d. Variable resistors.
    e. Cables.
    f. Continuity bonds.
    g. Cable splice kits.
    h. Cable labels.
    i. Cable terminals.
    j. Conduit.
    k. Backfill materials.
    l. Exothermic welding equipment (molds, cartridges, primer, caps).
    m. Dielectric coating systems for exothermic welds, metallurgical, and mechanical bonds.
    n. Isolation flange kits.
    o. Wax tape.

D. Installation instructions and plans:
1. Provide manufacturer’s installation instructions.
2. Plan to mitigate risk of groundwater contamination during installation and operation of the system.

E. Quality Control Submittals:
1. Testing data:
    a. Indicated test equipment, test method, and criteria requirement used for each test.
    b. Placement of reference electrode during each test (if applicable).
    c. Results of tests conducted.
        1) Locations of test stations, electrical continuity bonds, isolation.
            a) Use unique identifier and GPS coordinates.
            b) Include type of test station.
            c) List of cable identification in test stations.
        2) Electrical continuity checks.
        3) Isolation checks.

4) Native potential readings at each test station (for commissioning only).
5) ON and Instant-OFF potential readings at each test station.
6) Anode potentials.
7) Anode current output.
8) Indicate that exothermic welds passed the strike test with a peen hammer.
9) Analysis and discussion of any deficiencies identified and recommendations to correct such deficiencies.

1.05 QUALITY ASSURANCE

A. Installation and testing conducted by or under direction of cathodic protection technologist (NACE CP3) or cathodic protection specialist (NACE CP4).

B. Materials, installation, and testing:
   1. Consistent with corrosion engineering principles and practices in accordance with NACE SP0286, NACE TM0497, and NACE SP0169.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements and the manufacturer's instructions.

B. Material:
   1. Store off the ground.
   2. Protect against weather, condensation, and mechanical damage.
   3. Handle with care.
   4. Do not sharply bend or tightly coil wires.
   5. Replace equipment or materials damaged in shipment or installation.
   6. Isolation:
      a. Do not store insulated flange gaskets at job sites under direct sunlight or at temperatures exceeding 110 degrees Fahrenheit.
      b. Protect against mechanical damage.
   7. Anodes:
      a. Shipped in waterproof bags or wrapping and shall remain dry until installation.
      b. Coil the anode core cables and secure and package the anode in crates as required to prevent damage during shipping.
      c. Ensure that the cable is not damaged and that the anodes or lead connection at the anode end are not physically stressed.
      d. If anode or anode core cables are damaged, replace the complete anode.
   8. Anode backfill:
      a. Bulk or bag shipping.
      b. Shipped and stored in a manner to keep it dry in order to minimize it from freezing solid.
      c. If bagged, provide and ship in waterproof bags.
      d. Bags shall be UV resistant or protected with tarps to protect from UV exposure.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Electrical items shall be UL listed or labeled, where such listing or labeling is obtainable.

B. Provide cathodic protection systems for the following features as indicated on the Drawings:
   1. 4” W3 ductile iron pipe.
   2. 4” PD ductile iron pipe.
   3. 6” BS ductile iron pipe.
   4. 8” BS ductile iron pipe.

C. Provide isolation as indicated on the Drawings.

D. Provide joint bond cables for the cathodically protected ductile iron pipe per drawing CP150.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide corrosion-engineering services to furnish, install, and test galvanic cathodic protection systems:
   1. Include electrical continuity bonds, test stations, isolation, and accessory equipment and features as directed in this Section, or otherwise indicated.

B. Galvanic cathodic protection systems shall provide a minimum service life of 20 years.

2.03 ANODES

A. Manufacturers: One of the following or equal:
   1. Anode Systems Company, Grand Junction, CO.
   2. Farwest Corrosion Control, Downey, CA.
   3. Galvotec, McAllen, TX.
   4. MESA, Denver, CO.

B. Magnesium anodes shall be GA-MG-20 HP 20D2, or equal:
   1. High potential, in accordance with ASTM B843, Grade M1C with the following specifications:

Anode Composition: High Potential Magnesium	
Aluminum (Al)	0.010% maximum
Manganese (Mn)	0.50 to 1.30%
Copper (Cu)	0.02% maximum
Nickel (Ni)	0.001% maximum
Iron (Fe)	0.03% maximum
Silicon (Si)	0.05% maximum
Other Impurities - each	0.3% maximum
Magnesium (Mg)	Balance

   2. Open circuit potential of -1.7 volts or more negative in reference to a copper-copper sulfate reference electrode.
   3. Dimensions: Minimum bare weight of 20 lbs with an ingot length of 59.75 inches and a diameter of 3 inches.
   4. Anode backfill:
      a. Furnish anodes prepackaged in special backfill material consisting of 75 percent ground hydrated gypsum, 20 percent powdered bentonite and 5 percent anhydrous sodium sulfate.
   5. Factory anode-to-cable connection: Exposed mild steel core, and exposed copper cable potted in epoxy.
   6. Silver-solder connection between anode cable and mild steel core.
   7. Anode core cable:
      a. Minimum of 50 feet in length or sufficient length to reach the pipe and maintain 18” slack without being spliced, whichever is greater. In accordance with the Cable Details table in this Section

2.04 CATHODIC PROTECTION TEST STATIONS

A. Manufacturers: One of the following or equal:
   1. Cott Manufacturing, Pittsburg, PA.
   2. Farwest Corrosion Control, Downey, CA.
   3. Gerome Electric Supply Co, Uniontown, PA.
   4. Tinker & Rasor, New Braunfels, TX.

B. Test stations:
   1. Specifically constructed for cathodic protection system installations and intended environment.
   2. Protected as required for permanency.
   3. Provide terminals and associated hardware for the number and size of cables and required accessories:
      a. Provide a minimum of 7 terminals.
   4. Terminal lugs shall be high conductivity copper alloy manufactured specifically for making electrical connections, such as:
      a. Burndy Type KLU or KA4C lugs.
      b. Ilsco Type SLU, SLUH, or CP-4 lugs.

5. Cast aluminum, above ground type:
    a. TESTOX Series 100, Series 700, or Series 1000.
6. Flush in-ground type:
    a. Products:
        1) Brooks Model 3RT.
        2) Model G03.
    b. Details:
        1) As indicated on the Drawings.
        2) Include test station inside of box.

2.05 CABLES

A. Manufacturers: One of the following or equal:
    1. Corrpro Inc., Chicago, IL.
    2. Farwest Corrosion Control, Downey, CA.
    3. MESA Products, Tulsa, OK.

B. In accordance with ASTM B3.

C. Manufactured not more than 24 months prior to notice to proceed.

D. Single-conductor:
    1. Stranded, plain, annealed copper cable.

E. Insulation:
    1. Rated for 600 volts and direct immersion or burial.
    2. In accordance with ASTM D1248.
    3. Insulation as specified in the table below.

F. Suitable lengths to permit installation from terminus to terminus (e.g., structure-to-test station or structure-to-structure) free of splices and without stress, unless otherwise specified.

G. Cable gauges:
    1. Sizes are as specified in the table below, unless otherwise specified.

Cable Details			
Cable Type	**Cable Size (AWG)**	**Insulation**	**Color Code**
Structure cable	#10 or larger	HMWPE or THWN	Black
Galvanic anode cable/core cable	#10 or larger	HMWPE or THWN	Red
Joint bond cable	See Bond Details table	HMWPE or THWN	Black
Continuity bond cable	See Bond Details table	HMWPE or THWN	Black

2.06 CONTINUITY BONDS AND CONTINUITY JOINT BONDS FOR PIPE

A. Manufacturers: One of the following or equal:
    1. Erico International Corp, Solon, OH.
    2. Hoff Company, Centennial, CO.

B. Connections on a joint bond shall be welded or soldered. Mechanical or compression type connections are not permitted.

C. Bonds and welds shall exhibit sufficient strength and flexibility to allow thermal movement of the pipe after pipe backfill without cracking or breakage.

D. Make bond connections to pipe with an Engineer approved welding method.

E. Insulated or coated copper with exposed copper field coated to prevent galvanic corrosion of the pipe.

F. Bond cable size as indicated in the Bond Details table.

2.07 CONDUIT

A. As specified in Section 26_05_29 - Conduits.

B. Rigid hot dipped galvanized steel conduit and fittings.
   1. Threaded at one end (minimum).
   2. Length as required for installation requirements.
   3. Diameter based on cable needs: 2-inch minimum.
   4. For cables installed above ground.

C. Schedule 40 PVC conduit and fittings.
   1. Length as required for installation requirements.
   2. Diameter based on cable needs: 2-inch minimum.
   3. For cables installed between buried metalwork.

2.08 TEST STATION MOUNTING POST

A. As indicated on the Drawings.

2.09 STRUCTURE CONNECTIONS

A. Manufacturers: One of the following or equal:
   1. Continental Industries, Inc. (Thermo-Weld), Tulsa, OK.
   2. Erico Products Inc. (Cadweld), Cleveland, OH.

B. Exothermic metallurgical welds - Cable to structure connections.
   1. Thermite weld materials consist of wire sleeves, welders, and weld cartridges according to the weld manufacturer’s recommendations.
   2. Exothermic metallurgical weld system designed for:
      a. Cathodic protection systems.
      b. Metallic substrate material.
      c. Weld orientation.
   3. Exothermic reaction must produce molten copper, which produces a permanent, high conductivity connection.
   4. Exothermic welds:
      a. Use a special alloy to provide minimum heat effect on substrate material.
      b. Shall have a current carrying capacity equal or better than that of the conductor.

5. Molds:
   a. Graphite: As recommended by the manufacturer for structure and cable size.
6. Adapter sleeves:
   a. For No. 12 AWG and No. 2 AWG wires.
   b. Prefabricated factory sleeve joint bonds or bond wires with formed sleeves made in the field are acceptable. Attach field-formed joint bonds sleeves with the appropriate size and type of hammer die furnished by the thermite weld manufacturer.
   c. Extend wire conductor 1/8 inch beyond the end of the adapter sleeve.
7. Cartridges:

Exothermic Weld Details		
Pipe Material	**Weld Type**	**Cartridge Size, Max.**
No. 6 AWG cable and smaller		
Steel	HA, VS HC	15 gm 25 gm
Ductile or cast iron	HB, VH HE	25 gm (XF-19) 32 gm (XF-19)
No. 4 AWG wire		
Steel	HA VS, HC	15 gm 25 gm
Ductile or cast iron	HB, HE VH, GR	45 gm (XF-19) 32 gm (XF-19)
No. 2 AWG wire		
Steel	FS	32 gm
Ductile or cast iron	FC	45 gm (XF-19)
Concrete cylinder pipe	HA GR	32 gm 45 gm
No. 1/0 AWG wire		
Steel	FS	32 gm
Ductile or cast iron	FC	45 gm (XF-19)
Concrete cylinder pipe	HA, GR	65 gm
No. 2/0 AWG wire		
Steel	FS	45 gm
Ductile or cast iron	FC	65 gm (XF-19)
Concrete cylinder pipe	HA, GR	65 gm
Copper strap joint bonds		
Steel	M-128	15 gm

2.10 DIELECTRIC COATING FOR CONNECTIONS, WELDS, AND CONTINUITY BONDS

A. Specifically designed for cathodic protection systems.

B. Applied with primer coat, as needed.

C. Suitable for intended environment.

D. Coat exposed weld nuggets, exposed cable, or structure metal using mastic coating.
   1. In accordance with NSF 61 if subject to immersion in potable water.

E. Manufacturers: One of the following or equal:
   1. Carboline, St. Louis, MO.
   2. Royston Laboratories, Pittsburgh, PA.

F. Product:
   1. Bitumastic 50.
   2. Roskote A51.
   3. Royston Handy Cap IP.

2.11 WAX TAPE COATING SYSTEM FOR BURIED FLANGES

A. General:
   1. Apply a wax tape coating system in accordance with AWWA C217.
   2. Consists of 3 parts: Surface primer, wax-tape, and outer covering.
      a. All 3 parts shall be the product of the same manufacturer.

B. Primer:
   1. A blend of petrolatum, plasticizer, and corrosion inhibitors having a paste like consistency.
   2. Pour point of 100 degrees Fahrenheit to 110 degrees Fahrenheit and a flash point of 350 degrees Fahrenheit.
   3. Trenton Wax-Tape Primer® or approved equal.

C. Wax tape:
   1. A synthetic-fiber felt, saturated with a blend of high melt microcrystalline wax, solvents, and corrosion inhibitors.
   2. Saturant pour point between 125 degrees Fahrenheit and 130 degrees Fahrenheit.
   3. Dielectric strength equal to a minimum of 100 volts per mil.
   4. Thickness shall be 50 mils to 90 mils in 6-inch wide rolls.
   5. Trenton No. 1 wax-tape or approved equal.

D. Outer covering:
   1. 2 layers of a plastic wrapper at total of one 150 gauge or three 50 gauge, wound together as a single sheet.
      a. Clear polyvinylidene chloride, high cling membranes wound together as a single sheet.
   2. Trenton Poly-Ply™ or approved equal.

2.12 ISOLATION FLANGE KITS

A. Complete assembly shall have an ASME rating equal to or higher than that of the joint and pipeline.

B. Materials and pre-assembled isolating flange kits shall be suitable for the intended chemical exposure, operating temperatures, and operating pressures.

C. Manufacturers: One of the following or equal:
   1. Advanced Products and Systems, Scott, LA.
   2. Central Plastics Co., Shawnee, OK.
   3. GPT Industries, Houston, TX.

D. Flange kit:
   1. Full-face insulating gasket, an insulating sleeve for each bolt, insulating washers, and steel washers:
      a. Pipe diameters up to 36 inches: 1 insulating washer and 1 steel washer on each side of flange for each bolt.
      b. Pipe diameters larger than 36 inches: Insulating washers shall be sandwiched between a pair of matching steel washers on each side of the flange for each bolt.
   2. Isolating gaskets:
      a. Gasket retainers shall be full face, Type E, NEMA G-10 glass reinforced epoxy retainers with an ethylene propylene diene monomer (EPDM) rubber rectangular cross section O-ring seal.
      b. Minimum total gasket thickness shall not be less than 1/8 inch.
      c. Gasket shall have the same outside diameter as the pipe flange.
         1) For steel pipe, the gasket's inside diameter shall be equal to the inside diameter of the pipe's steel cylinder.
         2) At valve to pipe connections where the inside diameters are not equal, the gasket's inside diameter shall be equal to the smaller of the 2 inside diameters.
      d. Certified in accordance with NSF 61.
      e. Dielectric strength shall be not less than 550 volts per mil, and compressive strength shall be not less than 50,000 psi.
      f. Installed within 6 months of date of manufacture.
      g. Product:
         1) Linebacker 61 insulating gasket, or equal.
   3. Insulating sleeves:
      a. Full-length one-piece Mylar or fiberglass reinforced epoxy (NEMA G-10 grade).
      b. Dielectric strength shall be not less than 400 volts per mil.
      c. Length of the insulating sleeves shall provide an air gap between the end of the insulating sleeve and inside surface of the stud bolt nut with a tolerance of 1/32 inch minimum and 1/8 inch maximum.
         1) Adjusted for the actual thickness of the steel washers and insulating washer thickness.
   4. Insulating washers:
      a. Fiberglass reinforced epoxy (NEMA G-10 grade).
      b. Minimum thickness of 1/8 inch.

c. Dielectric strength shall not be less than 550 volts per mil, and compressive strength shall not be less than 50,000 psi.
d. Inside diameter shall be sized to fit over the insulating sleeve's outside diameter.

5. Steel washer:
   a. In accordance with ASTM F436.
   b. Inside and outside diameter shall match those of the insulating washers.
   c. Able to freely rotate around the insulating sleeve.
   d. Attention must be paid to the fit between the steel washers and the insulating sleeve to avoid twisting and cracking of the sleeves when the flange bolts are torqued.

2.13 CONCRETE FOOTINGS

A. ASTM C94, ready-mixed concrete.

2.14 SAND BACKFILL

A. ASTM C33, fine aggregate.

2.15 MISCELLANEOUS MATERIALS

A. Test station wire terminations:
   1. One-piece, tin-plated crimp on ring tongue connector.

B. Compression connectors:
   1. For in-line and tap splices shall be "C" taps made of conductive wrought copper.
   2. Sized to fit the wires being spliced.
   3. Applied with the crimp tool and die recommended by the manufacturer for the wire and tap connector size.
   4. Burndy Type "YC", or equal.

C. Electrical tape:
   1. Linerless rubber high-voltage splicing tape and vinyl electrical tape suitable for moist and wet environments.
   2. Scotch 130C and Scotch 88.

D. Warning tape:
   1. Polyethylene for anode cables:
      a. Minimum 3-inches wide.
      b. Red or yellow with black lettering.
      c. Suitable for direct burial.
   2. Print full length of tape with the following:
      a. "Caution - Cathodic Protection Cable Buried Below".

PART 3 EXECUTION

3.01 GENERAL

A. Electrical isolation:
   1. Structures to be cathodically protected shall be electrically isolated from other extraneous metal (e.g., casings, foreign structures, and rebar in concrete).

B. Dielectric materials, other than designated non-metallic carrier pipe, that might cause shielding of cathodic protection current (e.g., plastic debris) shall not be left around structures, including areas within excavation sites.

3.02 INSTALLATION

A. Galvanic anodes:
   1. Install vertically as follows:
      a. Minimum 5 feet from nearest part of structures to be protected, if possible.
      b. Minimum 1 anode length from non-metallic structures.
      c. Depth:
         1) Top of anode 3’ below grade.
   2. Remove outer water-resistant covering (plastic or paper bag) on pre-packaged anodes before installation. Do not damage wettable covering containing backfill and magnesium.
   3. Do not support anodes by their cables.
   4. Do not wet pre-packaged anodes until they are in the ground, surrounded with compacted earth, and covered by at least 1 foot of compacted backfill.
   5. Do not connect anodes to structures at test stations; energize systems only at time of testing.
   6. Connect individual galvanic anodes to structures through individual calibrated 0.01 ohm shunts within the test station for current measurement (1 shunt for each anode).
      a. As indicated on the Drawings.

B. Test stations:
   1. General:
      a. Mount and wire the test stations as indicated on the Drawings.
      b. Uniquely label each test station**.**
      c. Cable sizes as specified in the Cable Details table in this Section.
   2. Location:
      a. Readily accessible.
      b. Not likely to be damaged or interfere with personnel and/or equipment (e.g., adjacent to above ground structures).
      c. As close to the structure connection as possible.
   3. Cathodic protection test stations:
      a. As indicated in the Drawings.

C. Cable:
   1. Inspect for insulation defects prior to backfilling:
      a. Replace cable if insulation is damaged.
   2. Install without kinks, stresses, and/or splices.

3. Identify origin of cables terminating in an enclosure:
    a. Cable identification as to distinct originating structure or anode as indicated on the Drawing(s).
    b. Printed letters on shrinkable label attached to cables clearly visible within the enclosure.
    c. Encase printed labels in clear heat shrink tubing.
4. Connect to test station with crimped, ring-tongue connectors.
5. Size of cable as specified in the Cable Details table in this Section.
6. Run cable through PVC conduit underground and rigid galvanized conduit once cable emerges from ground, as indicated on the Drawings.
7. Structure cables:
    a. 2 cables per structure at each test station.
    b. Connect cables to structures by exothermic metallurgical welding as indicated on the Drawings.
        1) Make exothermic metallurgical bond in accordance with the bonding supply manufacturer's instructions.
        2) Coat bare copper, weld nugget, and ferrous materials at metallurgical bonds with an approved dielectric metallurgical bond coating.
            a) Allow dielectric material to cure before repair of damaged structure coating or lining.
8. Anode cables (also called anode core cable):
    a. Installed free of splices.
    b. Terminate at the test station as indicated on the Drawings.

D. Isolation:
1. Install to electrically isolate the structure from other metallic structures.
2. Align and install isolation joints according to the manufacturer's recommendations to avoid damaging materials.
3. Test before backfill to ensure isolation is satisfactory.
    a. Damaged or defective insulation parts shall be replaced.
4. Locations:
    a. As indicated on the Drawings.
    b. Between dissimilar metals, unless indicated on the Drawings.

E. Electrical continuity bonds:
1. Provide metallurgical bonds at mechanical type joints (e.g., non-welded joints) between ferrous parts included in a particular cathodic protection system as specified in this Section, or as necessary to ensure electrical continuity.
2. Minimum number, type, and size of bond per bond joint is shown in the table below.
3. Bond cable installed with sufficient slack to prevent stress or tugging:
    a. Allow for minimum 1/2-inch joint movement.
4. Joint Bond locations:
    a. At each joint for cathodically protected ductile iron pipe.
5. Continuity bon locations:
    a. As indicated in the Drawings.

Bond Details			
Pipe Size	**Bond Type**	**Bond Length**	**Number of Bonds**
Joint Bonds			
36-inch Ductile iron pipe	No. 10 AWG cable	18 or 24 inch	2
Continuity bonds	No. 10 AWG cable	As needed to go from structure to test station with 18-inch slack	2

3.03 FIELD QUALITY CONTROL

A. Equipment:
   1. Portable multimeter: Fluke Model 179 or equivalent. Minimum input impedance of 10 megohms and capable of measuring DC voltages between 0.1 millivolt to 100 volts.
   2. Portable CSE reference electrode.
   3. Insulation checker: M.C. Miller Model MIC or equivalent.

B. Structure-to-soil potential:
   1. Verify that each test station is properly labeled.
      a. Unique identifier and GPS coordinates.
      b. Cable identification in test stations.
   2. Conduct testing in least 2 testing cycles:
      a. First testing cycle:
         1) Prior to energizing system:
            a) Test structure electrical continuity.
               (1) Determine voltage difference unchanged between structure cables.
               (2) Test station integrity.
                  (a) Determine voltage difference between cables within each test station and anode junction box enclosure.
            b) Measure native structure-to-soil potentials of buried metalwork.
               (1) At each individual test station location.
               (2) Place portable reference electrode as close to buried metalwork as possible for structure-to-soil potential measurements.
               (3) Saturate ground with water to reduce reference cell contact resistance.
         2) After the system is energized:
            a) Determine protective (uncorrected) and polarized structure-to-soil potentials in accordance with NACE TM0497.
               (1) At each individual test station location.
               (2) Place portable reference electrode as close to buried metalwork as possible for structure-to-soil potential measurements.
               (3) Saturate ground with water to reduce reference cell contact resistance.

b) Determine current output of each individual anode in test stations.
c) Adjust variable resistor setting for each anode to obtain required balance of current output (if variable resistors are required).

b. Second and subsequent testing cycles:
1) Time between testing cycles shall be 30 to 60 days.
2) Cathodic protection system shall not be adjusted between testing cycles.
3) Repeat testing required after energizing the system during the first testing cycle.
4) If data indicates that cathodic protection system requires adjustment to meet requirements, adjust cathodic protection system and conduct subsequent testing cycles within 30 to 60 days.

c. Troubleshoot and correct problems.

3. Submit final data after last testing cycle when performance criteria have been met and no further adjustments are needed.

C. Electrical continuity:
1. Test completed continuity bonds prior to and after backfilling.
Quality control test shall be performed on bonds after installation but before backfilling or closing the structure.

D. Isolation:
1. Check isolation flanges, couplings, sleeves, and washers to ensure adequate electrical isolation prior to backfilling or closing the structure using a portable multimeter, ohmmeter, or isolation checker in accordance with the manufacturer's written instructions.
2. Verify isolation of bolts used with isolation kits.
3. Use isolation checker in accordance with the manufacturer's written instructions, or other approved method.
4. Conduct additional isolation testing as needed to ensure that isolation is not electrically shorted to other equipment or concrete reinforcement.
5. Replace damaged or defective isolation identified during testing.
6. Concrete reinforcement:
a. Pipe penetrations shall be tested for electrical isolation from electrical grounding and concrete reinforcement.
b. Perform tests where concrete reinforcement isolation is required.
c. Conduct testing prior to concrete placement and shall be monitored during concrete placement to ensure no electrical shorts occur.
d. Electrical shorts detected and identified shall be repaired

END OF SECTION

SECTION 28_46_13

FIRE ALARM SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design and installation of fire alarm systems.

1.02 REFERENCES

A. Regulations:
   1. As specified in Section 01_41_00 - Regulatory Requirements.

B. Standards:
   1. Federal Communications Commission (FCC).
   2. National Fire Protection Association (NFPA):
      a. 1 - Fire Code.
      b. 70 - National Electrical Code.
      c. 72 - National Fire Alarm and Signaling Code.
      d. 75 - Standard for the Protection of Information Technology Equipment.
      e. 90A - Standard for the installation of Air Conditioning and Ventilation systems.
      f. 1221 - Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems.
   3. National Institute for Certification in Engineering Technologies (NICET).
   4. Underwriters Laboratories, Inc. (UL):
      a. 864/1730 - Standard for Control Units and Accessories for Fire Alarm Systems.

1.03 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Fire alarm system design.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Delegated Design Submittals:
   1. Product data for fire alarm system components and materials.
   2. Shop Drawings:
      a. Furnish all Shop Drawings required to obtain approval of the fire alarm system by the authority having jurisdiction (AHJ).
   3. Calculations.

C. Installation instructions:
   1. Provide manufacturer's installation instructions.

D. Designer and installer qualifications.

E. Submit AHJ's approval.

F. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
   3. Manufacturer's Certificate of Functional Compliance as specified in Section 01_75_17 - Commissioning.

G. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

H. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.

1.05 QUALITY ASSURANCE

A. Installer qualifications:
   1. NICET Level II Fire Alarm System Technician.
   2. Installation to be supervised by NICET Level III Technician.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements and the manufacturer's instructions.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Furnish Submittals to the local authority having jurisdiction (AHJ), for review and approval of the proposed system.
      a. Pay all plan check, permit, and inspection fees.

1.09 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.10 MAINTENANCE

A. Furnish service and maintenance of fire alarm system for 1 year from date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Design, furnish, and install fire alarm systems in the following locations:
   1. Retrofitted 420 Sludge Storage Building (previously 420 Chlorine Scrubber Building).

2.02 MANUFACTURERS

A. One of the following or equal:
   1. Edwards Signaling Solutions.
   2. Honeywell.
   3. Siemens Fire Safety Solutions.

2.03 DESIGN AND PERFORMANCE CRITERIA

A. Provide a complete, non-coded, microprocessor-based fire alarm system with initiating devices, notification appliances, controls, and supervisory devices.

B. Alarms from the fire alarm system shall be routed to:
   1. Master Fire Alarm Control Panel located in existing Building 710 as indicated on the Drawings.
   2. PLC as indicated on the Drawings.

2.04 EQUIPMENT

A. All fire alarm system equipment and materials shall be UL listed.

B. Fire alarm equipment shall be rated for the installed location as indicated on the Drawings and as specified in Section 26_05_00 - Common Work Requirements for Electrical.

2.05 COMPONENTS

A. Conduit:
   1. Use the conduit type for the installed location as specified in Section 26_05_00 - Common Work Results for Electrical.
   2. Provide conduit as specified in Section 26_05_33 - Conduits.

B. Boxes:
   1. Provide boxes as specified in Section 26_05_34 - Boxes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install system components and associated devices in accordance with applicable NFPA Standards and manufacturer’s recommendations.

B. Smoke detectors shall not be installed until after construction cleanup on all trades is complete and final in accordance with NFPA 70, NFPA 72, NFPA 75, NFPA 90A, FCC, and other codes applicable to the individual installation location.

C. Locate the fire alarm control panel as indicated on the Drawings.

D. Wiring:
   1. Conduit and wiring systems:
      a. Size, provide, and install necessary conduits and wiring systems necessary to meet the requirements of the approved fire alarm system design.
      b. Installed in accordance with the NEC, state, and local codes.

E. Furnish Manufacturer's Certificate of Installation Verification.

3.02 FIELD QUALITY CONTROL

A. Provide services of a factory-authorized service representative to:
   1. Supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
   2. Verify proper installation, correct deficiencies, and be present at the job site during final inspection by the Engineer.

B. Functional Testing:
   1. Witnessed.
   2. Notify the Engineer and the AHJ in writing a minimum of 2 weeks before the scheduled day for the field acceptance tests.
   3. Furnish the services of a field service engineer, and any special tools, equipment and labor to perform the tests.
   4. Each device and control function shall be individually witness tested and recorded:
      a. Acceptance tests shall be witnessed by and signed off by the Engineer, the FASS's field engineer, the installing Subcontractor, and a representative of the AHJ.
   5. Furnish test reports and the Manufacturer's Certificate of Functional Compliance.

3.03 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations 2.
      b. Maintenance 2.

END OF SECTION

SECTION 31_00_00

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to Site grading for buildings, basins, reservoirs, boxes, roads, and other facilities.
   2. Backfilling and compacting under and around structures.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.

C. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3).WSDOT Standard Specifications for Road, Bridge and Municipal Construction, 2022 Edition.

D. “Geotechnical Design Services - Post Point Sludge Tank Replacement” by GeoEngineers, dated December 19, 2024. This report summarizes geotechnical site explorations, design, and construction recommendations.

E. City of Bellingham Development Guidelines and Improvements Standards.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Backfill adjacent to structure: Backfill within volume bounded by the exterior surfaces of structure, the surface of undisturbed soil in the excavation around structure, and finish grade around structure.
   2. Embankments: Dikes, levees, berms, and similar facilities.
   3. Excavation: Consists of loosening, removing, loading, transporting, depositing, and compacting in final location, wet and dry materials, necessary to be removed for purposes of construction of structures, ditches, grading, roads, and such other purposes as are indicated on the Drawings.

1.04 SUBMITTALS

A. Copy of Property Owner’s Agreement allowing placement of surplus soil material on their property.

B. Excavation plan:
   1. Pile installation.

C. Gradation analysis and moisture density curves for all imported materials.

1.05 QUALITY ASSURANCE

A. Initial compaction demonstration:
   1. Adequacy of compaction equipment and procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
      a. 50 cubic yards of backfill adjacent to structures.
      b. 100 cubic yards of embankment work.
      c. 100 cubic yards of fill.
      d. 50 cubic yards of roadway base material.
      e. 100 cubic yards of road fill.
   2. Compaction sequence requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.
   3. After satisfactory conclusion of initial compaction demonstration and at any time during construction, provide confirmation tests as specified under the Field Quality Control article.

B. Perform Work related to this Section in accordance with the approved Stormwater Pollution Prevention Plan (SWPPP).

1.06 SEQUENCING AND SCHEDULING

A. Schedule earthwork operations to meet requirements specified in this Section for excavation and uses of excavated material.

B. If necessary, stockpile excavated material in order to use it at specified locations.

C. Excavation, backfilling, and filling: Perform excavation, backfilling, and filling during construction in manner and sequence that provides drainage at all times.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
   1. Where mud or other soft or unstable material is encountered, remove such material and refill space with stabilization material. Wrap stabilization material with stabilization fabric.
   2. Obtain acceptable import material from other sources if surplus obtained within the Project Site does not conform to specified requirements or are not sufficient in quantity.
   3. No extra compensation will be made for hauling of fill materials nor for water required for compaction.

2.02 MATERIALS

A. Water for compacting: Use water from source acceptable to the Engineer.

B. Soil and rock materials:
   1. General:
      a. Provide aggregate base course, controlled low-strength material, sand where specified or indicated on the Drawings.
   2. Aggregate base course materials: As specified in Section 31_05_15 - Soils and Aggregates for Earthwork.
   3. Sand: As specified in Section 31_05_15 - Soils and Aggregates for Earthwork.

C. Controlled low-strength material: As specified in Section 31_23_24 - Controlled Low Strength Materials (CLSM).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Character and quantity of material:
      a. Examine the site before commencing work and shall make his own deductions and conclusions as to the nature of materials to be encountered and difficulties anticipated. Verify character and quantity of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in Work to be performed.
      b. Determine gradation, shrinkage, and swelling of soil, and suitability of material for use intended in Work to be performed.
      c. Determine quantity of material, and cost thereof, required for construction of backfills, cuts, embankments, excavations, fills, and roadway fills, whether from on-site excavations or imported materials. Include in cost of Work to be performed.
      d. Include wasting of excess material, if required, in the cost of Work to be performed.
      e. Data results of a subsurface investigation of the site and soil conditions are included in Geotechnical Engineering Report.
      f. The Owner makes no representation as to the correctness of the information contained in the Geotechnical Engineering Report. Any use made of the report by the Contractor is at his sole risk. Contractors shall make whatever investigations as are necessary to determine what measures are necessary to successfully complete the work in accordance with the Contract. The Contractor shall anticipate all work necessary to perform the tasks required to complete the Work as indicated on the Plans and specified herein: including, but not limited to, sheeting, shoring, dewatering, stabilizing slopes, and any other work of temporary nature not a part of the permanent finished structure, lines, and grade.

3.02 PREPARATION

A. Backfills:
   1. After clearing and excavation are completed, scarify entire areas that underlie backfills or structures to a depth of 6 inches and until surface is free of ruts (1-inch diameter or more), hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified before placing backfill material or concrete.
   3. Do not place backfill against walls until:
      a. Walls have been cast full height of structure and concrete has reached the specified strength.
      b. Connecting slabs and beams have been cast, and concrete has reached the specified strength.
   4. Prior to backfilling:
      a. Remove forms.
      b. Clean trash and debris from the excavation site.
   5. After inspection of foundation, walls, and pipes, place backfill symmetrically around structures to prevent eccentric loading of structures.

B. Embankments:
   1. After clearing is completed, scarify entire areas that underlie embankments to a depth of 6 inches and until surface is free of ruts (1-inch diameter or more), hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified for embankments before placing of embankment material.

C. Fills:
   1. Granular fill material placed under slab-on-grade floors, foundations, roadways, and parking lots. All Structural fill shall comply with the recommendations in the Geotechnical Report.
   2. After clearing is completed, scarify entire areas that underlie fill sections or structures to a depth of 6 inches and until surface is free of ruts (1-inch diameter or more), hummocks, and other features that would prevent uniform compaction by equipment to be used.
   3. Recompact scarified areas to density specified for compacted fills before placing of fill material or concrete.

D. Roadway fills:
   1. After clearing is completed, scarify entire areas that underlie roadway fills to a depth of 6 inches and until surface is free of ruts (1-inch diameter or more), hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified for roadway fills before placing of roadway fill material.

E. Sloped surfaces for fill or foundations:
   1. Foundations for fill having slopes in excess of 1 vertical to 4 horizontal:
      a. Bench or terrace to adequately key existing ground and fill built thereon.

2. Slopes of original hillsides and old fills: Bench minimum of 10 feet horizontally as fill is placed.
3. Provision of new benches:
    a. Start new bench wherever vertical cut of next lower bench intersects existing grade.
    b. Recompact material thus cut out along with new embankment material at no additional cost to the Owner.

3.03 INSTALLATION

A. General:
1. Dispose of excavated materials that are not required or are unsuitable for fill and backfill in lawful manner.
2. Dispose of surplus material on private property only when written permission agreement is furnished by the owner of the property. Submit copies of such agreements.
3. Rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension: Remove from the Project Site at no additional cost to the Owner.
4. Stabilization of subgrade: Provide materials used, or perform Work required, to stabilize subgrade so it can withstand loads that may be placed upon it by the Contractor's equipment.

B. Borrow area: There is no borrow area on the Project Site.

C. Compaction:
1. Provide specified compaction for backfills, cuts, embankments, fills, roadway fills, and other earthwork.
2. Perform confirmation tests to verify and confirm that Work has complied, and is complying at all times, with compaction requirements specified in this Section for initial compaction demonstration and field quality control testing.
3. In-place density of compacted backfills, cuts, embankments, fills, and roadway fills determined in accordance with ASTM D1556.
4. Maximum density, laboratory compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D1557.
5. To prevent damage to structures due to backfilling operations, place backfill with equipment that does not exceed AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading, within a distance from the face of the structure of not less than 1/2 the depth of backfill.
    a. Depth of backfill is the distance between the level being compacted and the bottom of the excavation. Outside this distance, heavier compaction equipment may be used.
6. Compact to percentage of maximum density as follows:
    a. Backfill adjacent to structures: 95 percent.
    b. Backfilling voids: 95 percent.
    c. Other areas: 90 percent.
    d. Under present and future structures: 95 percent.
    e. Under roadways, parking and storage areas, curbs, and sidewalks: 95 percent.
    f. Upper 6 inches of cuts: 95 percent.
    g. Fills: 95 percent.

7. Proof roll with heavily loaded rubber-tired construction equipment for the following locations:
    a. Under roadways, parking and storage areas, curbs, and sidewalks.
    b. Backfill adjacent to structures.
    c. Under future structures.

D. Dewatering: As specified in Section 31_23_19 - Dewatering.

E. Excavation:
1. Blasting: Not permitted.
2. Utilities: Protect private and public utilities from damage in accordance with WSDOT Standard Specification 1-07.17.
3. Excavations for trenching: As specified in Section 31_23_35 - Trenching.
4. Excavations for structures:
    a. Provide excavations conforming to the dimensions and elevations indicated on the Drawings for each structure.
    b. After clearing is complete, excavate for the structure, down to the elevation indicated on the Drawings. Unless directed by the Engineer, do not carry excavations below elevation indicated on the Drawings.
    c. Where soil is encountered having unsuitable bearing value, the Engineer may direct in writing that excavation be carried to elevations below those indicated on the Drawings.
    d. Where excavations are made below elevations indicated on the Drawings, adjust elevations of excavations in accordance with the following requirements:
        1) Under slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section.
        2) Under footings: Restore to the proper elevation using one of the following:
            a) Aggregate base course.
            b) Controlled low-strength material.
    e. Excavation width:
        1) Extend excavations at least 2 feet clear from walls and foundations of structures to allow for placing and removal of forms, installation of services, and inspection.
        2) Do not undercut slopes.
    f. Difficulty of excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.
    g. Engineer shall inspect subgrade prior to placing structural fill.
5. Excavation of lined channels:
    a. Excavations in open cut for lined channels may be made so as to place concrete directly against excavated surfaces providing faces of excavations are:
        1) Firm and unyielding.
        2) Will stand or can be made to stand without sloughing.
    b. Excavations to provide subgrade for lined channel or subdrainage material: Excavate to lines and grades indicated on the Drawings.
6. Excavation of unlined channels and basins:
    a. Excavate to lines and grades indicated on the Drawings.
    b. Perform excavation and grading so that finish surfaces are in uniform planes with no abrupt breaks in surface.

7. Excavation of ditches and gutters:
    a. Cut ditches and gutters accurately to cross sections and grades indicated on the Drawings.
    b. Take care not to excavate ditches and gutters below grades indicated on the Drawings.
    c. Backfill excessive ditch and gutter excavations to grade with suitable material acceptable to the Engineer.
    d. Do not deposit any material within 3 feet of edge of ditch unless otherwise indicated on the Drawings.
8. Necessary over excavation:
    a. Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified in backfilling of voids below, or as acceptable to the Engineer.
    b. Backfill voids with material acceptable to the Engineer:
        1) With acceptance of the Engineer, backfill with one of the following:
            a) Aggregate base course.
            b) Controlled low-strength material.

F. Materials for backfills, embankments, fills, and roadway fills:
1. General:
    a. Obtain import material from other sources if surplus materials from cuts and excavations obtained from within the Project Site do not conform to specified requirements or are not sufficient in quantity for construction of Project.
2. Backfills:
    a. Backfill adjacent to structures, slabs, or walls:
        1) Aggregate base course material unless otherwise indicated on the Drawings.
        2) Segregated native material as allowed by Engineer.
    b. Backfill material under concrete structures: Aggregate base course material. unless otherwise indicated on the Drawings.
    c. Extend backfill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
3. Embankments:
    a. Aggregate base course material. unless otherwise indicated on the Drawings.
4. Fills:
    a. Aggregate base course material. unless otherwise indicated on the Drawings.
    b. Extend fill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
5. Roadway fills: One of the following, unless otherwise specified or indicated on the Drawings:
    a. Aggregate base course material.

G. Placement:
1. General:
a. Lines and grades:
1) Construct backfills, embankments, fills, and road fills, at locations and to lines and grades indicated on the Drawings.
2) Overbuild permanent fill slopes by at least 1 foot and then cut to final grade to provide adequate compaction of the remaining fill.
2. Backfills:
a. Place loose material in successive layers that do not exceed 10 inches prior to compaction.
b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
c. Defective compacted backfills: Remove and recompact.
3. Fills:
a. Place loose material in successive layers that do not exceed 10 inches prior to compaction.
b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
c. Defective compacted fills: Remove and recompact.
4. Embankments:
a. Place loose material in successive layers that do not exceed 10 inches prior to compaction.
b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
c. Defective compacted embankments: Remove and recompact.
5. Roadway fills:
a. Place loose material in successive layers that do not exceed 10 inches prior to compaction.
b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
c. Defective compacted roadway fills: Remove and recompact.

3.04 FIELD QUALITY CONTROL

A. Confirmation tests:
1. Contractor's responsibilities:
a. Adequacy of compaction equipment and procedures:
1) Demonstrate adequacy of compaction equipment and procedures.
2) At each test location include tests for each type or class of backfill from bedding to finish grade.
b. Compaction sequence requirements:
1) Do not perform additional earthwork of the same kind until specified degree of compaction has been demonstrated.
c. Cost of confirmation tests: Paid for by the Contractor.
d. Qualifications of the Contractor's testing laboratory: Acceptable to the Engineer.
e. Copies of confirmation test reports: Submit promptly to the Engineer.
2. Frequency of confirmation testing:
a. Maximum dry density versus moisture:
1) Backfill: 100 cubic yards.
2) Cuts: 100 cubic yards.
3) Embankments: 100 cubic yards.

4) Fills: 100 cubic yards.
5) Roadway fills: 100 cubic yards.

B. Tolerances:
1. Finish grading of backfills, cuts, embankments, fills, and roadway fills:
a. Perform fine grading under concrete structures such that finish surfaces are never above the grade or cross section indicated on the Drawings and are never more than 0.10 feet below.
b. Provide finish surface for areas outside of structures that are within 0.10 feet of grade or cross section indicated on the Drawings.
2. Unlined channels and basins:
a. In both cut and fill, and levee and access road side slopes in cut: Vertical tolerance of none above and 3 inches below grade indicated on the Drawings on bottom and side slopes.
b. On top surface of levee and access road in both cut and fill, and levee and access road side slopes in fill: Vertical tolerance of none below and 3 inches above grade indicated on the Drawings.
3. Areas which are not under structures, concrete, asphalt, roads, pavements, sidewalks, dikes, and similar facilities:
a. Provide finish graded surfaces of either undisturbed soil, or cohesive material not less than 6-inches deep.
b. Intent of proceeding is to avoid sandy or gravelly areas.
4. Finish grading of surfaces:
a. Reasonably smooth, compacted, and free from irregular surface changes.
b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.
c. Uniformly grade areas that are not under concrete.
d. Finish ditches and gutters so that they drain readily.

C. Compliance tests:
1. Frequency of testing: Periodic compliance tests will be made by the Engineer to verify that compaction is meeting requirements previously specified.

3.05 ADJUSTING

A. Finish grades of excavations, backfills, and fills:
1. Repair and reestablish grades to required elevations and slopes due to any settlement or erosion that may occur from action of the elements or any other cause prior to final acceptance.

3.06 PROTECTION

A. Finish grades of backfills, cuts, excavations, and fills:
1. Protect newly graded areas from erosion and deterioration by action of the elements.

B. Ditches and gutters:
1. Maintain ditches and gutters free from detrimental quantities of debris that might inhibit drainage until final acceptance.

END OF SECTION

SECTION 31_05_15

SOILS AND AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Material requirements for soils and aggregates.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   5. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   6. D4829 - Standard Test Method for Expansion Index of Soils.

B. Washington State Department of Transportation (WSDOT):
   1. Standard Specifications (Standard Specifications).

C. “Geotechnical Design Services - Post Point Sludge Tank Replacement” by GeoEngineers, dated December 19, 2024. This report summarizes geotechnical site explorations, design, and construction recommendations.

D. City of Bellingham Development Guidelines and Improvements Standards.

1.03 SUBMITTALS

A. Product data:
   1. Material source.
   2. Gradation.
   3. Testing data.

B. Quality control for aggregate base course:
   1. Test reports: As required by Sections of Standard Specifications.
   2. Certificates of compliance: As required by Sections of Standard Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection: Protect from segregation and excessive moisture during delivery, storage, and handling.

B. Comply with Standard Specifications storage requirements, if applicable.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

A. Provide material having maximum particle size not exceeding 4 inches and that is free of trash, lumber, debris, leaves, grass, roots, stumps, and other organic matter.

B. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

C. Comply with soil and aggregate material requirements in the Standard Specifications, unless specified otherwise.

2.02 NATIVE MATERIAL

A. Allowed only by approval of Engineer. Reuse of select native material may require segregation of materials. See Geotechnical Report for additional information.

2.03 AGGREGATE BASE COURSE

A. Aggregate base course must consist of granular material, sand, gravel, and shall not contain shale, soft, poor durability products, nor organic, recycled material (glass, shredded tires, concrete rubble, asphaltic concrete rubble, etc.) or deleterious material per Standard Specifications 9-03.14(1) with the following conditions:
   1. 3/4-inch: 100% passing.
   2. U.S. No. 4: Maximum 70% passing.
   3. U.S. No. 200: Maximum 5% passing.

2.04 SAND

A. Clean, coarse, natural sand.

B. Non-plastic when tested in accordance with ASTM D4318.

C. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and ASTM C136:

Sieve Size (Square Openings)	Percent by Weight Passing Sieve
1/2 inch	100
No. 200	0 - 20

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 31_10_00

SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Providing all labor, materials, tools, and equipment necessary for clearing, grubbing, stripping and disposing of all vegetation and debris. Prior to the start of clearing and grubbing, the Owner shall clearly mark the clearing limits in the field.

1.02 REFERENCES

A. United States Code of Federal Regulations (CFR):
   1. 40 - Protection of Environment.
      a. 503 - Standards for the Use or Disposal of Sewage Sludge.

B. WSDOT Standard Specifications for Road, Bridge and Municipal Construction, 2022 Edition.

C. “Geotechnical Design Services - Post Point Sludge Tank Replacement” by GeoEngineers, dated December 19, 2024. This report summarizes geotechnical site explorations, design, and construction recommendations.

D. City of Bellingham Development Guidelines and Improvements Standards.

1.03 DEFINITIONS

A. Clearing: Consists of removal of natural obstructions and existing foundations, buildings, fences, lumber, walls, stumps, brush, weeds, rubbish, trees, boulders, utility lines, and any other items which interferes with construction operations or are designated for removal.

B. Grubbing: Consists of the removal and disposal of wood or root matter below the ground surface remaining after clearing and includes stumps, trunks, roots, or root systems greater than 1 inch in diameter or thickness to a depth of 6 inches below the ground surface.

C. Stripping: Includes the removal and disposal of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped. The depth of stripping is estimated to be 6 inches in vegetated areas and 12 inches in in developed areas, but the required depth of stripping will be determined by the Engineer.

1.04 QUALITY ASSURANCE

A. Regulatory requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.

B. Pre-construction conference: Meet with Engineer to discuss order and method of work.

1.05 PROJECT CONDITIONS

A. Environmental requirements:
   1. For suspected hazardous materials found: As specified in Section 01_35_44 - Hazardous Material Procedures.

1.06 SEQUENCING AND SCHEDULING

A. Clearing and grubbing: Perform clearing and grubbing in advance of grading operations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine site and verify existing conditions for beginning work.

3.02 PREPARATION

A. Protect existing improvements from damage by site preparation work.

3.03 INSTALLATION

A. General
   1. Contractor shall exercise care as to not encroach or disturb vegetation outside of the marked clearing limits.
   2. Vegetation and debris must be hauled to a legal waste site obtained by the Contractor. All costs associated with disposing of grubbed vegetation and debris shall be incidental to the contract.

B. Clearing:
   1. Clear areas where construction is to be performed and other areas as indicated on the Drawings, or specified in this Section, of fences, lumber, walls, stumps, brush, roots, weeds, trees, shrubs, rubbish, and other objectionable material of any kind which, if left in place, would interfere with proper performance or completion of the work, would impair its subsequent use, or form obstructions.

2. Do not incorporate organic material from clearing and grubbing operations in fills and backfills.
3. Contractor's temporary construction facilities: Fill or remove pits, fill, and other earthwork required for erection of facilities, upon completion of the work, and level to meet existing contours of adjacent ground.

C. Grubbing:
1. From excavated areas: Grub stumps, roots, and other obstructions 3 inches or over in diameter to depth of not less than 18 inches below finish grade.
2. In embankment areas or other areas to be cleared outside construction area: Do not leave stumps, roots, and other obstructions higher than the following requirements:

Height of Embankment over Stump	Depth of Clearing and Grubbing
0 feet to 2 feet	Grub stumps or roots 3 inches or over in diameter to 18 inches below original grade. Cut others flush with ground.
2 feet to 3 feet	Grub stumps 1 foot and over in diameter to 18 inches below original grade. Cut others flush with ground.
Over 3 feet	Leave no stumps higher than stump top diameter, and in no case more than 18 inches.

3. Backfill and compact cavities left below subgrade elevation by removal of stumps or roots to density of adjacent undisturbed soil.

D. Stripping:
1. Remove soil material containing sod, grass, or other vegetation to depth of 6 inches in vegetated areas and 12 inches in developed areas to receive fill or pavement and from area within 5 feet outside foundation walls.
2. Deposit stripped material in accordance with following requirements:
   a. Disposed offsite.

END OF SECTION

SECTION 31_23_19

DEWATERING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation and maintenance of dewatering systems.
   2. Disposal of water entering excavation or other parts of the work.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

1.03 SUBMITTALS

A. Dewatering plan:
   1. Dewatering design analysis.
   2. Required permits.
   3. Arrangement, location, and depths of dewatering system components.
   4. Type and sizes of filters.
   5. Identify proposed alignment, support, and protection for discharge pipe. Identify location of discharge and provide details for that location. For pipes discharging to manholes, provide details of pipe entry at manhole.

B. Well construction logs. Include:
   1. Descriptions of actual materials encountered, categorized in accordance with Unified Soil Classification System.
   2. Construction details.
   3. Well development procedures and results.
   4. Deviations from original design.

C. Qualifications:
   1. Dewatering contractor.
   2. Dewatering design engineer.
   3. Testing laboratory.

1.04 QUALITY ASSURANCE

A. Dewatering plan and dewatering system analysis:
   1. Prepared by a qualified Civil Engineer, licensed in the state where the Project is located.
      a. The dewatering design engineer shall have at least 5 years of experience in designing similar systems.

B. Dewatering Contractor shall have at least 8 years of experience in installing similar systems.

C. Testing laboratory shall meet discharge permit testing laboratory qualifications.

D. Regulatory requirements:
   1. Obtain required water discharge permits.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
   1. Keep excavations reasonably free from water. Draw down static groundwater level to minimum of 1 feet below anticipated bottom of excavations before the excavation reaches bottom elevation.
   2. Dewatering design analysis. Include the following:
      a. Evaluation of anticipated subsurface conditions.
      b. Required well spacing.
      c. Diameter of wells.
      d. Depth to screen, screen height, and mesh size.
      e. Backfill and filter pack.
      f. Pump size.
      g. Drawdown duration.
      h. Drawdown and steady state flow rates.
      i. Plans for de-silting of groundwater before discharge.
      j. Anticipated area influenced by dewatering system and potential impacts to adjacent structures, existing and proposed. Mitigation measures needed to prevent any expected settlements. Contingency plan for restoring nearby structures if settlement is observed as result of dewatering operations. Frequency of surveying.
      k. Expected settlements.
      l. Action plan for subsidence.
   3. Include water drawdown curves in dewatering calculations.
   4. Coordinate dewatering design with excavation and shoring design. Excavation and shoring design shall consider changes in groundwater conditions and associated earth pressures.
   5. Do not place concrete or masonry foundations or concrete slabs in water. Do not allow water to rise over these elements until concrete or mortar has set for at least 24 hours.
   6. Maintain operation of dewatering system until complete structure -- including walls, slabs, beams, struts, and other structural elements -- has been constructed; concrete has attained its specified compressive strength; and backfill has been completed to finish grade.
   7. Provide standby power to ensure continuous dewatering in case of power failure.

B. Dewatering shored excavations:
   1. Dewater from within shoring.
   2. Use impermeable shoring system to minimize lowering of groundwater outside shoring.
   3. Extend impermeable shoring below bottom of excavation sufficient amount to:
      a. Minimize lowering of groundwater outside shoring.
      b. Prevent unstable excavation due to piping and heave.
   4. To minimize settlement outside shoring due to dewatering, do not lower groundwater outside shoring more than 1 foot. Provide groundwater recharge if required to maintain this groundwater elevation outside of shoring.
   5. Provide monitoring wells located outside shoring for monitoring groundwater elevation.

C. Obtain written permission from Engineer before locating wells, well points, or drain lines for dewatering within the limits of a structure's foundation.

D. Locate dewatering facilities where they will not interfere with utilities and construction work to be performed by others.

E. Discharge:
   1. Discharge water to as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with Contractor.

B. During construction, provide and maintain ample means and devices to promptly remove and properly dispose of water entering excavation or other parts of the work, whether water is surface water or underground water.

C. Keep excavations reasonably free of water.

D. Make provisions to maintain continuous dewatering:
   1. Provide standby power to maintain dewatering during power outages and interruptions.
   2. Provide 24-hour monitoring by personnel skilled in operation and maintenance of the system, and capable of providing or obtaining work required to maintain system operation.

E. Monitoring wells:
   1. Provide at least 1 groundwater level monitoring well. If more than 4 dewatering wells or well points are installed, provide 1 additional monitoring well for every 4 dewatering wells or well points.
   2. Locate monitoring wells within 6 feet of excavation and mid-way between dewatering wells or well points.

3. Provide temporary threaded cap, not less than 2 inches in diameter at the top of wells.
4. Protect dewatering wells in place during excavation.

F. Intercept and divert precipitation and surface water away from excavations. Use dikes, curb walls, ditches, pipes, sumps, or other means acceptable to Engineer.

G. Disposal of water:
1. Dispose of water from the work in suitable manner without damage to adjacent property.
2. Do not drain water into work built or under construction.
3. Properly dispose of discharge water in accordance with Federal, State, and local requirements and permits and in such manner that it will not be a menace to public health or safety.
4. For discharge of water into holding tanks or infiltration ponds, include a means of overflow protection that is acceptable to Engineer.

H. Wells, well points, and drain lines for dewatering:
1. Provide after receiving Engineer's written acceptance.
2. Fill dewatering wells, pipes, and French drains to be left in place within structure foundation limits with Class “C” concrete as specified in Section 03_30_00 - Cast-in-Place Concrete or grout as specified in Section 03_60_00 - Grouting.

3.02 CONSTRUCTION

A. Prior to release of groundwater to its static level: Confirm that:
1. All groundwater pressure relief devices for structure are fully operational.
2. Construction of structure is complete and concrete has reached its specified compressive strength.
3. Backfill of structure is complete.

B. Control release of groundwater to its static level to prevent disturbance of natural foundation soils or compacted backfills and fills and to prevent flotation or movement of structures, pipelines, or other facilities.

3.03 FIELD QUALITY CONTROL

A. Monitoring wells:
1. Record groundwater levels at least once a week. Submit readings to Engineer within 1 week.

END OF SECTION

SECTION 31_23_24

CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Controlled low strength material (CLSM), also known as "flowable fill" and “controlled density fill.”

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 229R - Report on Controlled Low-Strength Materials.
   2. 301 - Specifications for Structural Concrete.

B. ASTM International (ASTM):
   1. C94 - Standard Specification for Ready Mix Concrete.
   2. C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
   3. C150 - Standard Specification for Portland Cement.
   4. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
   5. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   6. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3)).
   7. D4832 - Standard Test Method of Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
   8. D5971 - Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material.
   9. D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material.

1.03 SUBMITTALS

A. Product data: Submit data completely describing materials in the mix and demonstrating compliance with the requirements of this Section.
   1. Cement: Mill tests. Indicate alkali content representative of each shipment.
   2. Fly ash: Identify source and type of fly ash.
   3. Water: Identify source and quality if not from a municipal treatment source.
   4. Admixtures: Manufacturer’s product data indicating suitability for use in CLSM mixes and recommended dosage rates.
   5. Aggregate:
      a. Submit source, type, and sieve analyses. Resubmit at any time there is a significant change in grading of materials.

B. Mix design:
   1. Submit full details, including mix design calculations for mix proposed for use.
   2. Trial batch test data:
      a. Submit data for each test cylinder.
      b. Submit data that identifies mix and slump for each test cylinder.

1.04 DELIVERY, STORAGE AND HANDLING

A. Store or stockpile cement, fly ash, and aggregate in accordance with ACI 301.

B. Store admixtures in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Mixture of portland cement, water, pozzolan, fine aggregate and admixtures, proportioned in accordance with the recommendations of ACI 229 to produce a homogeneous mixture that is flowable, that will readily work into corners and angles; that will not segregate in the plastic state; and that is self-compacting at the time of placement without the use of mechanical vibration.

B. Performance requirements:
   1. Air content, total calculated in accordance with ASTM D6023: Not less than 8.0 percent, nor greater than 12.0 percent.
   2. Compressive strength, measured in accordance with ASTM D4832 at 28 days: Not less than 50 pounds per square inch, nor greater than 150 pounds per square inch.
   3. Wet density: Not greater than 132 pounds per cubic foot.
   4. Slump, measured in accordance with ASTM C143 at the point of placement: Greater than 9 inches and that allows CLSM to flow freely and to be self-compacting during placement.

2.02 MATERIALS

A. Cement:
   1. Portland cement in accordance with ASTM C150, Type II.
   2. Having total alkali content not more than 0.60 percent.

B. Fly ash: Class C or Class F fly ash in accordance with ASTM C618.

C. Water:
   1. Potable water: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.

D. Admixtures: Products of a single manufacturer, specifically manufactured or recommended by that manufacturer for use in CLSM.
   1. Air entraining admixture: In accordance with ASTM C260.

E. Aggregate:
   1. Non-expansive, non-reactive, inert natural sand conforming to the following requirements:
      a. Not more than 12 percent passing a No. 200 sieve.
      b. No plastic fines present.
      c. Including pea gravel no larger than 3/8 inch.

2.03 MIXES

A. See Design and Performance Criteria for performance requirements of the plastic and hardened mix.

2.04 SOURCE QUALITY CONTROL

A. Trial batch:
   1. After mix design has been accepted by Engineer, have trial batch of the accepted mix design prepared by testing laboratory acceptable to Engineer.
   2. Prepare trial batches using the specific cement, fly ash, admixtures, aggregates, and water proposed for the Work.
   3. Prepare trial batch with quantity sufficient to determine slump, workability, and consistency; and to provide test cylinders as indicated in this Section.

B. Trial batch testing:
   1. Determine slump in accordance with ASTM C143, with the following modifications:
      a. Do not rod the concrete material.
      b. Place material in slump cone in one semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.
   2. Prepare and test trial batch specimens in accordance with ASTM D4832, with the following modifications:
      a. Provide cylindrical test specimens, each 6-inches in diameter by 12-inch high.
      b. Provide a minimum of 8 cylinders for testing of each trial batch.
      c. Fill the molds to overflowing and tap sides lightly to settle the mix.
      d. Do not rod the mix for consolidation in the cylinder.
      e. Strike off the excess material.
   3. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
   4. Do not remove the test cylinder from mold until that cylinder is to be capped and tested.
      a. Perform the capping carefully to prevent premature fractures.
      b. Do not perform initial compression test until the cylinders reach a minimum age of 3 days.
   5. Provide compressive strength tests:
      a. Test 4 test cylinders at 7 days after casting, and another 4 cylinders at 28 days after casting.
      b. The compression strength of the 4 test cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength.

C. If the trial batch tests do not meet the Specifications for strength or density, revise and re-submit the mix design, prepare additional trial batch(es), and complete additional trial batch tests. Repeat until an acceptable trial batch is that conforms to the Specifications is produced.
   1. All the trial batches and acceptability of materials shall be paid by the Contractor.
   2. After acceptance, do not change the mix design without submitting a new mix design, trail batches, and test information.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not place CLSM until preparation and condition of surfaces receiving the fill have been observed and accepted by the Engineer.

B. Remove debris foreign matter, and standing or running water from excavations and areas receiving CLSM before placement.

3.02 INSTALLATION

A. Pipes and trenches.
   1. Install cellular concrete as indicated on the Drawings and specified.
   2. Where CLSM is placed around and over pipes, secure pipes in place, or place CLSM in lifts to prevent pipe flotation.
   3. Where CLSM is placed in long, open trenches, confine material using bulkheads of sandbags, earth dams, or stiffer concrete at open ends of placement.

B. Soil preparation:
   1. Prior to placement of CLSM, prepare underlying soils as follows:
      a. Scarify surface to a depth of 8 inches.
      b. Adjust moisture content to or slightly above the optimum in accordance with ASTM D1557.
      c. Re-compact scarified surface to a minimum of 95 percent relative density in accordance with ASTM D1557.

3.03 MEASURING, BATCHING, MIXING AND TRANSPORTING

A. Measure, batch, mix and transport CLSM in accordance with the requirements of ASTM C94 and this Section.

B. Mix until there is uniform distribution of materials.

C. Discharge mixer completely prior to recharging.

D. After trial batch testing and mix acceptance, maintain slump during construction within plus or minus 1 inch of the design slump.

3.04 PLACING

A. Place controlled low strength material by method that preserves the quality of the material in terms of compressive strength and density.

B. Maintain fluid properties of the mix during placement.
   1. At point of placement, provide material that flows easily around, beneath, or through walls, pipes, conduits, or other structures.
   2. Do not place CLSM that has partially hardened or that has been contaminated by foreign materials.
   3. Handle and place CLSM using methods that minimize segregation of the mix.
   4. Deposit mix as near its final position as possible to avoid segregation due to rehandling or flowing.
   5. Contain and confine mix while it is fluid. Design containment structures and bracing at walls and forms to withstand lateral pressures of wet mix.

C. Lifts:
   1. Limit lift heights of CLSM placed against structures and other facilities that could be damaged due to the pressure from the CLSM, to the lesser of 3 feet or the lift height indicated on the Drawings.
   2. Do not place another lift of CLSM until the last lift of CLSM has set and gained sufficient strength to prevent additional lateral load against the forms or structure due to the weight of the next lift of CLSM.

D. Water conditions:
   1. Do not place CLSM in standing or flowing water.
   2. Do not permit water to flow over the surface of freshly placed or un-hardened CLSM.
   3. Do not submerge CLSM in water within 24 hours after placement.

E. Manage CLSM bleed water.
   1. Grade top surface of CLSM to drain away from the fill.
   2. Provide side containment that permits bleed water to drain to a contained management area away from the fill.

3.05 CURING AND PROTECTION

A. Curing:
   1. Prior to and during curing, install barriers to prevent equipment or personnel from falling into or becoming entrapped in CLSM.

B. Protect CLSM from:
   1. Damage from the elements.
   2. Damage of any nature during surrounding construction operations.
   3. Freezing: Do not use salt, manure, or other chemicals to provide protection from cold temperatures.

3.06 FIELD QUALITY CONTROL

A. Provide quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control and Section 01_45_17 - Contractor Quality Control Plan and as specified in this Section.

B. General:
   1. Engineer inspection and acceptance required prior to placement.
   2. Make provisions for and furnish all material for the test specimens, and provide manual assistance to assist the Owner's Testing Laboratory in preparing said specimens.

3.07 FIELD QUALITY ASSURANCE

A. Provide quality control over the work of this Section as specified in Section 01_45_00 - Quality Control and Section 01_45_17 - Contractor Quality Control Plan.

B. Field inspections:
   1. Engineer shall provide on-site inspection for the Work of this Section.
   2. Advise Engineer of readiness to proceed at least 24 hours prior to each placement of CLSM.
   3. Required inspections:
      a. Engineer will observe the prepared areas. Do not place CLSM until Engineer has observed and accepted preparations.
   4. Record of inspections.

C. Field sampling and testing:
   1. During construction, Owner shall provide sampling and testing to determine whether the CLSM, as produced and placed, complies with the requirements specified.
      a. Make provisions for and furnish material for test specimens. Cooperate by allowing free access for Owner's independent testing firm to sample and test materials. Provide assistance in obtaining and preparing said specimens.
   2. Sample CLSM for testing in accordance with ASTM D5971.
   3. Required tests:
      a. Air content: Prepare sample and test in accordance with ASTM D6023.
      b. Compressive strength: Prepare and test cylinder specimens in accordance with ASTM D4832.
         1) Prepare 6-inch diameter by 12-inch high specimens for testing.
            a) Provide one set of specimens for each 150 cubic yards of CLSM placed, but not less than 1 set for each half day's placement.
            b) Prepare and test not less than 3 cylinders for each set.
            c) Place CLSM in the molds in accordance with ASTM D4832. Do not rod or otherwise consolidate the material in the mold.
            d) In accordance with ASTM D4832 recommendations for displacing bleed water at the top of the molds and refilling the molds before covering with a lid. Do not use air-tight lids.

2) Place the cylinders in a safe location away from construction activities.
    a) Protect cylinders from bumping and impact.
    b) Maintain temperature surrounding cylinders between 60 and 80 degrees Fahrenheit until delivery to the laboratory for testing.
    c) After the first day, surround molds with a high humidity environment by covering with wet burlap, or equivalent highly absorptive material. Maintain saturation of the cover. Do not sprinkle water directly on the cylinders.
3) After 4 days, place the cylinders in a protective container for transport to the laboratory for testing.
    a) Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
    b) Transport container may be a box with a Styrofoam or similar lining that will limit jarring and bumping of the cylinders.
4) Upon receipt at the testing laboratory, place test cylinders in a moist curing room until dates for testing.
5) Do not remove test cylinders from molds until the day that cylinders is to be capped and tested.
6) Cap and test for compressive strength in accordance with ASTM D4832.
    a) Do not perform initial compression test until the cylinders reach an age of at least 4 days.
    b) Test 1 cylinder at 7 days and 2 at 28 days.
7) Compressive strength of the cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength specified.

3.08 NON-CONFORMING WORK

A. When testing or observation indicates CLSM with properties outside the specified and accepted range, Engineer will issue instructions regarding disposition of nonconforming materials.

B. Engineer may:
    1. Reject CLSM represented by those test specimens and require its removal and replacement.
    2. Require modification of the mix design to provide CLSM with the properties specified.

C. Make such modifications at no additional expense to the Owner and with no adjustment to the schedule.

END OF SECTION

SECTION 31_23_35

TRENCHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Trench excavation and trench backfill for pipelines, manholes, vaults, and appurtenances.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
   2. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Backfill: Material placed in trench above the pipe embedment zone.
   2. Bedding: Material placed under, around, and over pipes or ducts in trenches.
   3. Fine grading: Bedding material placed directly below pipes or ducts to provide support at the bottom of the trench and to bring those elements to required grades and elevations.
   4. Flexible pipe: Includes steel, ductile iron, thermoplastics such as polyvinyl chloride (PVC) and high-density polyethylene (HDPE), thermosetting plastics such as fiberglass-reinforced polymer (FRP), bar-wrapped concrete cylinder pipe, and corrugated steel pipes.
   5. Haunch zone: Material placed below and beside the pipe up to the pipe springline.
   6. Lift: A layer of soil or aggregate material, measured before compaction.
   7. Maximum density, Field Compaction: Soil density and water content when tested in accordance with ASTM D1556.
   8. Maximum density, Laboratory Compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D1557.
   9. Pavement section: Includes pavement plus underlying courses such as base course and subgrade.
   10. Pipe embedment zone: Includes bedding, fine grading, and haunch zone.
   11. Pipe foundation: Material placed at the bottom of trench to provide support.
   12. Pipe foundation: Stabilization material placed at the bottom of trench to provide support when the trench bottom is not firm, dry or uniform.

13. Pipe springline: A horizontal reference line located at mid-height, or halfway point, of a circular conduit, pipe, or tunnel. It is the maximum horizontal dimension or diameter of a circular conduit, pipe, or tunnel.
14. Rigid pipe: Includes reinforced non-cylinder concrete, reinforced concrete cylinder, prestressed concrete cylinder, vitrified clay, polymer concrete, cast iron, asbestos cement and cast-in-place pipes.

1.04 SUBMITTALS

A. As specified in Section 01_33_00 - Submittal Procedures.

B. Product data on soils and aggregates.
   1. Material source.
   2. Gradation.
   3. Test data to demonstrate compliance with requirements as specified in this Section.

C. Samples:
   1. Provide 50-pound sample of materials when requested by the Engineer.

D. Confirmation testing:
   1. Certification of Contractor's testing laboratory.
   2. Record copy report for tests performed by Contractor's testing laboratory.

PART 2 PRODUCTS

2.01 MATERIALS

A. As specified in Section 31_05_15 - Soils and Aggregates for Earthwork.

B. Class C concrete: As specified in Section 03_30_00 - Cast-in-Place Concrete.

C. Controlled low-strength material: As specified in Section 31_23_24 - Controlled Low Strength Material (CLSM).

PART 3 EXECUTION

3.01 PREPARATION

A. Stabilize excavations as specified in Section 31_50_00 - Excavation Support and Protection.

B. Perform subsurface utility engineering (SUE) for utility locating and verification prior to any excavation work.

3.02 DEWATERING

A. As specified in Section 31_23_19 - Dewatering.

3.03 TRENCH EXCAVATION

A. Excavate bottom of trench to depth indicated on the Drawings.

B. Areas of new fill or embankment:
   1. Prior to laying pipes or electrical service, place fill and compact as specified to not less than 2 feet above top of pipe, conduit, or duct bank.
   2. Excavate through fill for pipe trench.

C. Trench widths as specified in the following table:

Buried Pipe or Accessory	Minimum Trench Width	Maximum Trench Width
Nominal Pipe Diameter: 4-inch to 24-inch	OD + 18 inches	OD + 24 inches
Nominal Pipe Diameter: Greater than 24-inch	OD + 24 inches	OD + 36 inches
Manholes, vaults, valves, or other accessories	12 inches between outer surface and trench side or shoring	Not applicable

D. Potable water pipe and appurtenances:
   1. Lay in trenches separate from those used for sewers and recycled water.
   2. Unless otherwise specified or indicated on the Drawings, lay in trenches having cover of not less than 3 feet below surface of ground located at distance of not less than 10 feet clear horizontally from any parallel sewer and 1 foot clear vertically above any parallel sewer.

E. At road crossings or existing driveways:
   1. Provide notification, vehicular access, and traffic control as required by permits and special conditions.
   2. Provide temporary asphalt or plating for traffic or access at the end of each work day unless approved in writing by the Engineer.
   3. If unexpected utility conflicts or changed site conditions require trenchless technologies or temporary bridges, immediately notify the Engineer in writing. Approval is required before proceeding with construction.
   4. When trench width at top of pipe is increased beyond width specified in this Section because of soil conditions, safety requirements, or other reasons, Engineer approval for remedy is required without additional cost to the Owner.
      a. Remedy may include upgrade laying conditions or install stronger pipe designed in accordance with Specifications.

3.04 TRENCH BACKFILL - GENERAL

A. Trench area terminology and locations as indicated on the Drawings.

B. Place material, except CLSM and concrete, in maximum 6-inch lifts, measured before compaction.

C. Backfilling of manhole excavation: Conform to backfilling requirements for trenches as specified in this Section.

3.05 PIPE FOUNDATION

A. Provide trench bottom with firm, dry, uniform bearing surface at the grade indicated on the Drawings.

B. Excess excavation below elevation indicated on the Drawings will require installation of pipe foundation material to bring the trench bottom back to the elevation indicated on the Drawings at no additional cost to the Owner.
   1. Materials and placement:
      a. Aggregate base course.

C. If bottom of trench excavation consists of soil:
   1. Scarify bottom of trench to a depth of 6 inches below the grade indicated on the Drawings.
   2. Materials and placement:
      a. Recompact scarified material to 95 percent of maximum density.

D. If bottom of trench excavation consists of rock or any material that, by reason of its hardness, cannot be excavated to provide uniform bearing surface:
   1. Remove such rock or other material to a depth of not less than 4 inches below pipe embedment zone.
   2. Materials:
      a. CLSM.
      b. Class C concrete.

E. If bottom of trench excavation consists of mud or other soft unstable material:
   1. Remove such unacceptable material to a depth of not less than 18 inches below pipe embedment zone.
   2. Material and placement:
      a. Aggregate base course.

3.06 PIPE EMBEDMENT ZONE

A. Pipe displacement:
   1. Take necessary precautions in placement and compaction of bedding material to prevent displacement of piping.
   2. In event there is movement or floating of the piping, re-excavate, re-lay, and backfill the pipe.

B. Fine grading:
   1. Place 6 inches of approved haunch zone bedding material from the trench bottom to the bottom of the pipe or duct to provide support at the bottom of the trench and to bring those elements to required line and grade.

C. Depressions for joints or couplings:
   1. Excavate holes in the fine grading material at the bottom of the trench.
   2. Provide holes of sufficient width to provide ample room for grouting, banding, or welding as necessary for making joints and to ensure that pipe rests upon prepared trench bottom and not supported by any portion of the joint.

D. Rigid pipe:
    1. Pipe embedment zone: Below pipe springline:
        a. Materials and placement:
            1) Aggregate base course compacted to 95 percent maximum dry density.
    2. Pipe embedment zone: Above pipe springline:
        a. Compacted to a depth above pipe: 12-inch minimum.
        b. Materials and placement:
            1) Aggregate base course compacted to 95 percent maximum dry density.

E. Flexible pipe:
    1. Pipe embedment zone:
        a. Compacted to a depth above pipe: 12-inch minimum.
        b. Materials and placement:
            1) Aggregate base course compacted to 95 percent maximum dry density.

3.07 BACKFILL

A. Trenches:
    1. Materials and placement:
        a. Aggregate base course compacted to 95 percent maximum dry density.

B. Trenches in rock:
    1. Backfill to top of rock.
        a. Materials and placement:
            1) CLSM.
            2) Class C concrete.
    2. Backfill from top of rock to grade, if applicable:
        a. Materials and placement:
            1) Aggregate base course compacted to 95 percent of maximum density.

C. Trenches below or within 10 feet of the outside perimeter of structures:
    1. Backfill to underside of structure.
    2. Materials and placement:
        a. Aggregate base course compacted to 95 percent of maximum density.
        b. CLSM.

D. Trenches in roadways and paved areas:
    1. Backfill trench to underside of pavement.
    2. Materials and placement:
        a. Aggregate base course compacted to 95 percent of maximum density.
        b. CLSM.

E. Trenches in areas outside the improved section of roadways or in open country:
   1. Backfill to to underside of topsoil layer.
   2. Materials and placement:
      a. Aggregate base course compacted to 90 percent of maximum density.

F. Trenches under existing intersecting pipes, duct banks, or conduits larger than 3 inches in diameter:
   1. Backfill from above top of new pipe embedment zone to springline of intersecting pipe or conduit.
      a. Extend backfill at least 2 feet on either side of intersecting pipe or conduit to ensure backfill material remains in place while other backfill is being placed.
      b. Materials and placement:
         1) CLSM, unless otherwise indicated on the Drawings.
   2. Backfill remainder of trench:
      a. Materials and placement:
         1) CLSM.
         2) Class C concrete.

3.08 EXCESS MATERIAL

A. Remove excess excavated material from the Project site as specified in Section 31_00_00 - Earthwork.

3.09 FIELD QUALITY CONTROL

A. Provide field quality control for the Work as specified in Section 01_45_00 - Quality Control.

B. Confirmation tests: As specified in Section 31_00_00 - Earthwork.
   1. Minimum frequency of confirmation testing:
      a. At each test location include tests for each type or class of backfill from bedding to finished grade.
      b. For trenches: 1 location every 200 linear feet.
      c. In open fields: 2 locations every 1,000 linear feet or 1 location every 200 cubic yards.
      d. Along dirt or gravel road or off traveled right-of-way: 1 location at every 500 linear feet.
      e. Crossing paved roads: 1 location at each crossing.
      f. Under pavement cuts or within 2 feet of pavement edges: 1 location every 400 linear feet.

C. Compliance tests:
   1. Make periodic compliance tests to verify that compaction is meeting requirements as specified in this Section.
   2. Perform remedial work if compaction test fails to meet specified requirements using one of the following methods:
      a. Remove and replace backfill at the proper density.
      b. Other means acceptable to the Engineer.

3. Retesting:
    a. Costs of retesting: Contractor is responsible for the costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements.
    b. Contractor's confirmation tests during performance of remedial work:
        1) Performance: Perform tests in manner acceptable to the Engineer.
        2) Frequency: Double amount specified for initial confirmation tests.

D. Piping system testing:
    1. As specified in Section 40_05_00.09 - Piping Systems Testing.

END OF SECTION

SECTION 31_25_14

SOIL SURFACE EROSION CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work includes but is not limited to following:
   1. Temporary measures to prevent soil erosion and sedimentation of storm sewers, streams or other bodies of water, for all work.

B. The Post Point Resource Recovery Plant operates under the authorization of coverage per the Department of Ecology Industrial Stormwater General Permit (WAR005561). All work occurring on the Post Point Recovery Plant site must comply with this permit.
   1. The Contractor shall reference the permit (See Project Manual, Appendix B-1) and the Project Special Provisions in development of a Stormwater Pollution Prevention Plan for this project. The Contractor shall be responsible for limiting any discharges of construction or process related fluid products such as plant influent, wastewater, solids, and any stormwater or runoff contacting untreated material during the course of the work. Immediate spill response and cleanup of any discharge related to the work of this contract shall be the Contractor's responsibility.

1.02 RELATED SECTIONS

A. Coordinate related work specified in other parts of the Project Manual, including but not limited to following:
   1. Section 32_90_01 - Landscaping.
   2. Section 31_10_00 - Site Clearing.
   3. Section 31_23_35 - Trenching.

1.03 REFERENCES

A. WSDOT Standard Specifications for Road, Bridge and Municipal Construction, 2025 edition.

B. Washington State Department of Ecology's 2024 Edition of the Stormwater Management Manual for Western Washington.

1.04 SUBMITTALS

A. Submit in accordance with Sections 01_33_00 - Submittal Procedures and the following
   1. Inlet protection products.
   2. Barrier fence.
   3. Track clean plates.
   4. Any other erosion control products proposed for use on the site.

1.05 QUALITY ASSURANCE

A. Installer shall be a Specialist.

B. Regulatory Requirements: Section 01_41_00 - Regulatory Requirements.

PART 2 PRODUCTS

2.01 MATERIALS

A. Quarry Spalls per Section 31_00_00 - Earthwork.

B. Straw Mulch. Per WSDOT 9-14.5(1) - Straw.

C. Inlet Protection Insert. Inlet protection insert shall be in accordance with City of Bellingham Standard Detail EC-620 - Catch Basin Insert.

D. Track Clean Plates. Track clean plates shall be Track CleanTM Construction Entrance Plates or approved equal. Plates must adhere to the guidelines of BMP C105: Stabilized Construction Entrance, found in Volume II of the WA State Ecology Stormwater Management Manual of Western Washington.

E. 6 foot-tall chain link fence.

PART 3 EXECUTION

3.01 PREPARATION

A. Planning Of Construction: Plan and coordinate to reduce sediment pollution. Install all site BMPs prior to the commencement of land disturbing activities. Minimize the area of disturbance. Keep the area of clearing and grubbing to the minimum necessary for construction.

3.02 INSTALLATION

A. Install in accordance with “Quality Assurance” provisions, “References,” and Specifications. Where these may be in conflict, the more stringent requirements govern.

B. Pump Water. Practice sound pump water management to reduce sediment production. Discharge pump water into stabilized surfaces and allow to filter through existing vegetation. Repair discharge areas, upon completion of construction, to pre-existing conditions or better. Do not pump water into adjacent wetlands, creeks, or rivers.

C. Stabilization. Stabilize all slopes, channels, ditches or any disturbed area as soon as possible after the final grade or final earthmoving has been completed. Upon completion of the project, stabilize all areas which were disturbed by the project to prevent accelerated erosion. Maintain any erosion and sedimentation control facility required or necessary to protect areas from erosion during the stabilization period.

D. Earthwork:
   1. Control excavation for site work operations. Stockpile the material removed from the excavation in area where a minimum of sediment will be generated and where other damage will not result from the piled earth.
   2. Stockpile topsoil separately and redistribute where shown on plans uniformly after grading.
   3. Protect all stockpiled soil materials form erosion through the use of plastic sheeting or similar temporary measures, secured against wind disturbance.
   4. Any area stripped of vegetation, where no further work is anticipated for a period of 14 calendar days, shall be immediately stabilized with an approved erosion control method such as seeding, mulching, netting, erosion control blankets, etc.
   5. All disturbed areas shall be promptly and thoroughly stabilized against erosion during periods of wet weather, particularly when work is not being performed at the site.

3.03 MAINTENANCE AND CLEANING

A. Maintenance. Maintain the erosion control measures and facilities in proper condition so that they will individually and collectively perform the functions for which they were designed. In order to ensure the effectiveness and proper maintenance of the measures and facilities, the Contractor and Owner shall make periodic inspections at sufficiently frequent intervals to detect any impairments of the structural stability, adequate capacity, or other requisites of the herein approved measures and facilities which might impair their effectiveness. Take immediate steps to correct any such impairment found to exist.

B. Cleaning: Leave installations clean; premises free from residue of work of this section.

C. Street Sweeping: If onsite measures fail to prevent soil migration to street, Contractor shall provide regular sweeping.

D. Inspection, or lack thereof, shall not relieve the contractor of the responsibility of maintaining erosion control at all times. The contractor should, therefore, check all erosion control periodically on their own to ensure adequacy.

END OF SECTION

SECTION 31_32_18.04

STABILIZATION FABRIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Woven stabilization fabric used for subgrade enhancement.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   2. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   3. D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   6. D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.03 DEFINITIONS

A. Stabilization Fabric: Woven geotextile fabric manufactured from polypropylene yarns.

1.04 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Installation Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Furnish stabilization fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.06 PROJECT CONDITIONS

A. Field measurements:
   1. Take field measurements to determine the exact lengths and dimensions of the surfaces to receive the fabric.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Propex, Geotex 315ST.
   2. Ten Cate Geosynthetics, Mirafi 600X.

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements:

Property[(1)]	Test Method	Unit	Requirements[(1)]
Grab Tensile Strength	ASTM D4632	lbs	315
Grab Elongation	ASTM D4632	%	15
Trapezoid Tear Strength	ASTM D4533	lbs	120
CBR Puncture Resistance	ASTM D6241	lbs	900
UV Resistance (strength retained at 500 hrs)	ASTM D4355	%	70
Apparent Opening Size (AOS)	ASTM D4751	US sieve	40
Permittivity	ASTM D4491	sec^{-1}	0.05
Flow Rate	ASTM D4491	gpm/ft^2	4
Notes: (1) Minimum average roll values.			

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of stabilization fabric.

3.02 PREPARATION

A. Surface preparation: During grading operations, take care not to disturb the subgrade. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented in this Section.

B. Place the stabilization fabric smoothly without folds or wrinkles.

C. Use special care when placing the stabilization fabric in contact with the soil so that no void spaces occur between the stabilization fabric and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than recommended by manufacturer.

E. Do not drag stabilization fabric across subgrade.

F. Make overlaps at ends of rolls in the direction of the aggregate placement with the previous roll on top.

G. Use lightweight dozers, if necessary. Do not allow equipment directly on stabilization fabric.

3.04 FIELD QUALITY CONTROL

A. Inspection: Before covering, the condition of the fabric will be observed by the Engineer to determine that no holes or rips exist in the fabric. Repair all holes or rips by placing a new layer of fabric extending beyond the defect in all directions, a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

SECTION 31_50_00

EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Designing, providing, maintaining, and removing excavation support and protection.
   2. Applicable Heron Colony restrictions to shoring activities.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. Guidelines of Engineering Practice for Braced and Tied-Back Excavations.

B. Department of the Navy Naval Facilities Engineering Command (NAVFAC):
   1. Design Manual 7.2 - Foundations and Earth Structures.
   2. Design Manual 7.3 - Soil Dynamics and Special Design Aspects.

C. United States Steel Corporation (USS):
   1. Steel Sheet Piling Design Manual.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. General engineering design practice: In area of the Project, performed in accordance with recent engineering literature on subject of shoring and stability of excavations.
   2. Shoring: A temporary structural system designed to support vertical faces, or nearly vertical faces, of soil or rock for purposes of excavation. Shoring includes cantilevered sheet piling, internally braced sheet piling, and other similar shoring systems. Sloping of the soil is not shoring.
   3. Support levels: Level of tiebacks, wales, rakers, bottom of excavation, and other types of support.

1.04 SUBMITTALS

A. Shop Drawings and calculations:
   1. Calculations for different load, support, and other conditions that occur during the sequence of installation of shoring, construction of facilities protected by shoring, and sequence of removal of shoring.
   2. Sketches showing the condition at various stages of installation and removal of shoring.
   3. Show on plan shoring, structures, pipelines, and other improvements located near shoring.

4. When utilities penetrate shoring, show location of penetrations on elevation of sides of shoring.
5. Show details for ground support and sealing around utility penetrations.
6. Indicate method used for installing driven shoring.

B. Control points and schedule of measurements:
1. Submit location and details of control points and method and schedule of measurements.
2. Survey data.

C. Detailed sequence of installation and removal of shoring:
1. Consider effects of ground settlement in sequence of installation and removal of shoring.
2. Provide sketches showing conditions at various stages in sequence of installation and removal of shoring.

D. Vibrator monitoring:
1. Vibration monitoring program.
2. Manufacturer's literature on vibration monitoring instrumentation.
3. Vibration monitoring data.

E. Settlement monitoring:
1. Proposed product for survey benchmark for settlement monitoring.

F. Furnish Submittals for excavation support and protection as complete package and include items required in this Section:
1. Incomplete Submittals will not be reviewed and will be returned for resubmittal as a complete package.

G. Furnish dewatering Submittals as specified in Section 31_23_19 - Dewatering with Submittals for excavation support and protection.

1.05 SEQUENCING

A. Do not begin construction of any shoring or excavation operations until:
1. Submittals for shoring and dewatering have been accepted.
2. Control points as specified in this Section and on existing structures and other improvements as indicated on the Drawings have been established and surveyed to document initial elevations and locations.
3. Materials necessary for installation are on site.

B. Furnish Submittals a minimum of 60 days prior to scheduled date to begin excavation work.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Where general engineering design practice is specified, provide Drawings and calculations that are performed and signed by civil or structural engineer registered in the state where the Project is located:
   1. Clearly disclose assumptions made, criteria followed, and stress values used for materials being used in design calculations.
   2. Submit list of references acceptable to the Engineer that substantiate appropriateness of design assumptions, criteria, and stress values.

B. Design requirements:
   1. General:
      a. Dewatering:
         1) Dewater soil inside shoring as specified in Section 31_23_19 - Dewatering.
         2) Do not lower groundwater outside of shoring more than 1 foot.
         3) Recharge groundwater outside shoring to limit groundwater draw down outside of shoring to amount specified above.
      b. When electing to design with material stresses for temporary construction higher than allowable stresses prescribed in building code as specified in Section 01_41_00 - Regulatory Requirements, increase in such stresses shall not exceed 10 percent of value of prescribed stresses.
      c. Minimum safety factor used for design shall not be less than 1.5.
      d. Calculated minimum depth of penetration of shoring below bottom of excavation shall be increased not less than 30 percent if full value of allowable passive pressure is used in design.
      e. Maximum height of cantilever shoring above bottom of excavation shall not exceed 15 feet. Use braced shoring when height of shoring above bottom of excavation exceeds 15 feet.
      f. Location of point of fixity for shoring shall not be less than half calculated minimum embedment depth below bottom of excavation.
      g. Generally acceptable references for design of shoring and excavations are as follows:
         1) ASCE Guidelines of Engineering Practice for Braced and Tied-Back Excavations.
         2) Caltrans California Trenching and Shoring Manual.
         3) NAVFAC Design Manual 7.2.
         4) NAVFAC Design Manual 7.3.
         5) USS Steel Sheet Piling Design Manual.
      h. Maximum total deflection of shoring at any point on shoring shall not be more than 1/2 inch.
      a. Shoring engineering firm shall obtain errors and omissions insurance for the Project for an amount of not less than 500,000 dollars.
      b. Shoring geotechnical firm shall obtain errors and omissions insurance for the Project for an amount of not less than 500,000 dollars.
   2. Soil anchors, rock anchors, and deadman anchors:
      a. Design tieback anchors for a safety factor of not less than 2 times calculated load from shoring.

b. Proof load production anchors to 125 percent of calculated load from shoring.
c. Lock off production anchors at calculated load from shoring.
d. Length of soil anchors used to calculate resistance to load from shoring shall not include any length within potential active pressure soil failure zone behind face of shoring.
e. Design tie rods for tieback anchors for 130 percent of calculated load from shoring.
f. Design tie rods for tieback anchors for 150 percent of the calculated load from shoring when tie rod couplers are used and for other conditions where stress concentrations can develop.

3. Set inside face of shoring back from structure not less than greater of following:
   a. 5 feet from face of wall.
   b. 2 foot-6 inches from edge of foundation.
   c. Depth of excavation below bottom of foundation.

C. Performance requirements:
1. General:
   a. Support faces of excavations and protect structures and improvements in vicinity of excavations from damage and loss of function due to settlement or movement of soils, alterations in ground water level caused by such excavations, and related operations.
   b. Specified provisions:
      1) Complement, but do not substitute or diminish, obligations of the Contractor for furnishing of safe place of work pursuant to provisions of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for protection of work, structures, and other improvements.
      2) Represent minimum requirement for:
         a) Number and types of means needed to maintain soil stability.
         b) Strength of such required means.
         c) Methods and frequency of maintenance and observation of means used for maintaining soil stability.
2. Provide safe and stable excavations by means of sheeting, shoring, bracing, sloping, and other means and procedures, such as draining and recharging groundwater and routing and disposing of surface runoff, required to maintain stability of soils and rock.
3. Provide support for trench excavations for protection of workers from hazard of caving ground.
4. Provide shoring:
   a. Where, as result of excavation work and analysis performed pursuant to general engineering design practice, as defined in this Section:
      1) Excavated face or surrounding soil mass may be subject to slides, caving, or other types of failures.
      2) Stability and integrity of structures and other improvements may be compromised by settlement or movement of soils, or changes in soil load on structures and other improvements.
   b. For trenches 5 feet and deeper.
   c. For trenches less than 5 feet in depth, when there is potential for cave-in.
   d. Where indicated on the Drawings.

5. For safe and stable excavations, use appropriate design, construction, and maintenance procedures to minimize settlement of supported ground and to prevent damage to structures and other improvements, including:
    a. Using stiff shoring systems.
    b. Following appropriate construction sequence.
    c. Using shoring system that is tight enough to prevent soil loss through the shoring.
    d. Using shoring system that extends far enough below bottom of excavation to prevent piping, heave, or flow of soil under shoring.
    e. Design for safety factor of not less than 1.50.
    f. Providing surface runoff routing and discharge away from excavations.
    g. Where dewatering inside shoring is necessary, recharge groundwater outside shoring as necessary to prevent settlement in area surrounding shored excavation.
    h. Where sheet piling is used, use interlocking type sheets:
        1) Sheet piles shall be continuous and driven in interlock.
        2) If bottom of the excavation is located below the water table, use “ball and socket” or “thumb and finger” type interlock.
    i. Not applying shoring loads to existing structures and other improvements.
    j. Not changing existing soil loading on existing structures and other improvements.
    k. Provide welded steel packing between soil retaining members such as sheet piles and wales and similar members when gap exceeds 1/2 inch before wales are loaded.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. Installation of shoring:
    1. Install means for providing safe and stable excavations as indicated in Submittals.
    2. Installation of shoring must accommodate the Heron Colony noise restrictions: The shoring is within the 656 foot seasonal quiet buffer which limits noise to less than 92 dB at the Heron Colony as shown in the Contract Documents. The seasonal restriction applies from January 15 to September 1.

B. Removal of shoring:
    1. Remove shoring by completion of the Work.
    2. Select shoring system and method of removal, which will minimize soil that sticks to shoring from creating voids and causing settlement.
    3. To prevent settlement caused by pulling shoring, fill voids with pressure injected grout:
        a. Inject grout starting at bottom of void and progressively fill void to grade.
        b. Minimize length of shoring removed ahead of grouting operation and limit time void is left ungrouted to prevent void from closing up before being grouted.
    4. Pressure preservative treated wood lagging may be left in place if acceptable to the Engineer.

C. Control points:
    1. Establish control points on shoring and on structures and other improvements in vicinity of excavation for measurement of horizontal and vertical movement:
        a. Set control points on shoring support system:
            1) Set points at distances not exceeding 25 feet at each support level.
    2. Promptly upon completion of construction of control points survey control points. Submit copy of field notes with measurement.
    3. Perform horizontal and vertical survey and measurement of control points at least once every week.
        a. Field notes shall show current measurement and change in measurement from first measurement taken.
    4. Set control points on corners of existing structures and on curbs, manholes, and other improvements at the locations indicated on the Drawings.
    5. Provide plumb bobs with horizontal targets indicating original position of plumb bobs in relation to shoring at control points.

D. Vibration monitoring:
    1. Measure vibration due to installation and removal of shoring.
    2. Do not exceed 0.2 inches per second at distance of 25 feet from shoring for installation and removal of shoring for following facilities:
        a. Area 440.
    3. Perform vibration monitoring continuously during installation and removal of shoring.
    4. Submit vibration monitoring program, including information on vibration monitoring instrumentation.
    5. Submit vibration monitoring data daily.

E. Settlement monitoring:
    1. Install at least 3 permanent benchmarks (PK nails or equivalent) for settling monitoring for edge of excavation.
    2. Install benchmarks in the following locations as directed by Engineer:
        a. Between Area 420 building and Area 440 excavation (within 2 feet of Area 420).
        b. Between Area 320 building and Area 440 excavation (within 2 feet of Area 320).
        c. Between pipe gallery south of Area 440 and Arear 400 excavation (within 1 foot of gallery).

F. Maintenance:
    1. Where loss of soil occurs, plug gap in shoring and replace lost soil with fill material acceptable to the Engineer.
    2. Where measurements and observations indicate possibility of failure or excessive movement of excavation support, determined in accordance with general engineering design practice, take appropriate action immediately.

END OF SECTION

SECTION 31_63_14

BORED AND AUGERED PILES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bored/augered piles.

B. Payment procedures:
   1. Payment for pile work as specified in Section 01_20_20 - Measurement and Payment.

1.02 SUBMITTALS

A. Product data: Description of equipment proposed for installing piles.

B. Shop drawings: Shop drawings of piles proposed for use on the Project showing details of piles, reinforcing, concrete mix design, calculations, and other information required to describe proposed materials and construction methods.

C. Pile location:
   1. Piling layout plan: Plan showing location of piles as indicated on the Drawings including:
      a. Assigned number for each pile as identification for use in pile installation record.
      b. Pile cutoff elevation.
      c. Pile tip elevation.
   2. Pile location survey.

1.03 PROJECT CONDITIONS

A. Project environmental requirements:
   1. Sound control:
      a. Muffle equipment for pile installation as necessary to comply with Federal, State, and local community noise regulations.
      b. Perform drilling and pile installation operations in manner such that noise levels do not exceed 55 dBA at any residential property boundary except for short periods of time as provided by local ordinances.
      c. Monitor and record noise levels from pile installation operations, as required for compliance with worker safety regulations:
         1) Monitoring costs and any costs associated with related construction and project shutdown delays necessitated while bringing noise levels in compliance with the preceding provisions shall be the responsibility of and be borne by the Contractor.

1.04 SEQUENCING AND SCHEDULING

A. Fabrication and installation of piles: Do not fabricate or install piles until submittals have been accepted by the Engineer.

B. Contractor to determine the sequence of construction of the auger cast piles in relation to the excavation and shoring. if auger cast piles for sludge holding tank and odor control facilities need to occur in separate steps or mobilizations this shall be accounted for in the contractor's submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONSTRUCTION

A. Site tolerances:
   1. Pile installation tolerances:
      a. As specified in Section 31_63_17 - Augered Pressure-Grouted Piles.

3.02 FIELD QUALITY CONTROL

A. Field measurements:
   1. Pile location survey:
      a. After piles are installed and prior to placing reinforcing steel, formwork, or concrete for the structure, prepare pile location survey showing coordinates of final location of butt of piles and elevations of butt of piles to accuracy of plus or minus 0.01 feet.
      b. Pile location survey shall be performed by Surveyor registered in the state where the Project is located.
      c. Provide survey that includes as minimum following information:
         1) Location coordinates of:
            a) Pile butts as indicated on the Drawings.
            b) Pile butts as installed.
            c) Calculate distances between location coordinates of pile butts as indicated on the Drawings and actual location coordinates of pile butts as installed.
         2) Elevation of pile butts:
            a) As indicated on the Drawings.
            b) Elevation of pile butts as installed.
            c) Calculate difference between elevations of pile butts as indicated on the Drawings and actual elevation of pile butts as installed.

3) Highlight piles that are not within specified tolerances for location in plan and butt elevation.
4) Provide preceding information in tabular form and keyed to a pile plan by pile number:
a) Provide pile plan that shows each pile for each structure.

d. Engineer will utilize pile location survey information to evaluate acceptability of pile locations.

3.03 ADJUSTING

A. Correction of defective pile work:
1. Pile work not in accordance with the requirements indicated on the Drawings and specified in the Specifications is considered defective.
2. Take corrective measures acceptable to the Engineer, if piles are damaged, out of tolerance, mislocated, or otherwise defective:
a. Cost of redesign of foundation elements by the Engineer required by reason of defective pile work shall be bourne by Contractor.
b. Allow 15 working days from submittal of pile location survey, for design of corrections for defective pile work.
3. Measures to be used to correct defective pile work will be selected by the Engineer. Corrective measures that may be acceptable to the Engineer include:
a. Installing additional piles at locations selected by the Engineer.
b. Pile caps will be redesigned by the Engineer and required details of modifications to pile caps will be given to the Contractor to accommodate piles that were installed out of tolerance.
4. Leave piles which are not accepted in the ground.
a. Cut off such piles at least 1 foot below bottom of pile cap and fill such holes with compacted aggregate base course material:
1) Fill tubes or holes with Class C concrete.

END OF SECTION

SECTION 31_63_17

AUGERED PRESSURE-GROUTED PILES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Augered pressure-grouted piles.
   2. Dewatering within piles.
   3. All other work normally related to the above or specified under this section.

B. Related work:
   1. Provide excavation to required depth below pile cut-off elevation and remove drilling spoil as specified in this Section.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   2. C33 - Standard Specification for Concrete Aggregates.
   3. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-Inch or 50-mm Cube Specimens).
   4. C150 - Standard Specification for Portland Cement.
   5. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

B. U.S. Army Corp of Engineers (USACE):
   1. Handbook for Cement and Concrete:
      a. CRD-C 79 - Standard Test method for Pigments for Integrally Colored Concrete.
      b. CRD-C 619 - Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.

1.03 SUBMITTALS

A. Shop drawings:
   1. A plan layout showing each pile and numbering scheme for all piles.
   2. Reinforcing steel details.
      a. In accordance with Section 03_20_00 - Concrete Reinforcing.
      b. Submit manufacturer’s data for all splicing devices.
   3. Grout mix design:
      a. Information and a description of materials to be used.
         1) Manufacturer’s technical data.
         2) Material test data report.
         3) As specified in Section 03_30_00 - Concrete.

b. Proportioning of all materials.
c. Laboratory compressive strength test data of the trial grout mixes.

4. Methods for augering and placing of grout and reinforcing steel.
5. Size, number, and installation sequence for each of the scheduled piles.

B. Equipment review and working plans:
1. Complete list of the equipment proposed for use, including the manufacturer's description of the characteristics of each piece of equipment.
2. Working plans of accessories showing compatibility with the size, configuration, handling, and requirements of the type of pile indicated.

C. Daily reports:
1. Provide a record for each pile driven or drilled and grouted. Provide daily reports which contain as a minimum the following information:
a. Project name.
b. Name of Contractor.
c. Identification mark.
d. Date and time of installation.
e. Pile type and size.
f. Elevation of point.
g. Elevation of butt - before and after cut-off or extension.
h. Ground elevation.
i. Horizontal deviation from plan location.
j. Plumbness deviation.
k. Nature and location of obstructions.
l. Location of dog legs crimping or buckling.
m. Unusual occurrences during drilling, or reinforcing and grout placement.
n. Water conditions in pile, if applicable.

D. Pile group layout drawings:
1. Submit plan showing as-built location of each pile group no later than 1 week following the completion of each pile group.
a. Show the design and as-built centroid of the group as well as the deviation of each pile from its design alignment.

1.04 QUALITY ASSURANCE

A. Engineer:
1. Piling operations will be continuously observed, and installed piles inspected by a qualified Engineer, selected and paid for by the Owner.

B. Testing agency:
1. All mortar testing during pile operations will be done by an approved testing laboratory selected and paid by the Owner.
a. Furnish testing agency access to work, facilities, and incidental labor required for testing and inspection.

C. Contractor qualifications:
1. Regularly engaged in the installation of augered pressure grouted pile foundation systems.

2. Minimum of 10 years previous experience on projects of similar size, complexity, and subsurface conditions.
    a. The job supervisor directly responsible for pile installation shall have a minimum of 10 years previous experience on augered pressure-grouted pile installation.
3. The crane operator or "keymen" who give directions to the crane operators shall have at least 2 years of experience.
4. Forward qualifications of crew to the Engineer for review prior to commencement of work.

D. Piles:
1. Meet requirements of the building code as specified in Section 01_41_00 - Regulatory Requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Reinforcing steel:
1. Unload and store reinforcing bars in such a manner that they will be kept free of mud. Store on timber skids while awaiting use.

B. Miscellaneous:
1. Store other materials in a weathertight and dry place until ready to use.
    a. Store packaged materials in their original unbroken package or container.

C. Equipment:
1. The equipment provided for installation of augered pressure grouted piles, is subject to acceptance by the Engineer.
    a. At least 10 working days prior to mobilization, provide the Engineer a complete list and technical description of the equipment.

D. Auger:
1. A full-size continuous-flight hollow-shaft, required for the specified pile diameter, to be rotated into the ground to the specified pile depth.
    a. The injection opening in the auger shaft shall be at the bottom of the auger head and below the cutting teeth.

E. Auger drive:
1. Use auger drive head having a minimum static weight of 4,000 pounds and drive of 150 horsepower.

F. Auger leads:
1. Prevent auger leads from rotating by a suitable stabilizing arm.

G. Crane:
1. Use crane equipped with torque converter drive system to permit a slow, continuous auger lifting (grouting) operation.

H. Pumping and mixing:
1. Use pumping and mixing equipment for preparation and handling of the mortar.

I. Mortar pump:
    1. Positive displacement pump capable of developing and maintaining a pressure of 350 pounds per square inch-gauge at the pump discharge.
        a. The combination of pump, diameter of hose, length of hose, and height of crane shall be such that the grout pressure is at least 100 pounds per square inch-gauge at the tip of the auger.

1.06 PROJECT CONDITIONS

A. General:
    1. Do not begin pile installation until the earthwork and settlement monitoring in the area where piles are to be installed has been completed as indicated in this Section.
    2. The Piling Contractor shall review the Geotechnical Report for this project and examine the subsurface conditions of the construction site. The data on the subsurface conditions as provided in the report are not intended as warranties of such subsurface conditions. It is expressly understood that the Owner and/or the Engineer will not be responsible for any interpretations or conclusions drawn there from by the Piling Contractor. The data are made available solely for the convenience of the Piling Contractor.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland cement: ASTM C150, Type II.

B. Fly ash: ASTM C618, Class F.

C. Sand: ASTM C33 with Fineness Modulus from 1.3 - 3.4.

D. Fluidifier:
    1. USACE CRD C-619; expansion not to exceed 5 percent.
    2. Fluidifier shall be a compound which will increase the flowability of the mix and assist in neutralizing the setting shrinkage of the mortar.
        a. Contractor's choice of fluidifier will be subject to acceptance by the Engineer.

E. Water: Clean and free from matter injurious to the mix.

F. Reinforcing steel: ASTM A615, Grade 60.

G. Mortar:
    1. Mixture of portland cement, a mortar fluidifier, sand, and water so proportioned and mixed to provide a mortar capable of maintaining the solids in suspension without appreciable water gain, but which may be pumped without difficulty and will penetrate laterally to fill voids in the soil.

2. Proportion to provide a hardened mortar having the design compressive strength of 4,500 pounds per square inch minimum at 28 days as determined by standard 2-inch cubes.
    a. Submit proposed mix design to the Engineer for acceptance not less than 6 weeks prior to the time of its first use.

PART 3 EXECUTION

3.01 PREPARATION

A. Layout:
    1. Pile locations will be staked out and maintained by a Registered Surveyor retained by the Pile Installer.
        a. Cross-stake pile locations so that centerlines are retained after driving.
    2. Surveyor shall establish and maintain permanent benchmarks as necessary for monitoring of elevations.
        a. Reference benchmarks to a common datum and place at locations not subject to disturbance by the pile installation operation and acceptable to the Engineer.

3.02 INSTALLATION

A. Install piles as specified in Section 31_63_14 - Bored and Augered Piles.

B. General:
    1. A continuous helical-flight hollow-shaft auger shall be drilled into the ground to the required depth.
        a. Inject specified mortar under pressure, through the auger shaft as the auger is being withdrawn, using the earth-filled auger to retain the shape of the hole.
        b. Positively rotate the auger as it is being withdrawn.
    2. Do not install within 8 hours of the installation of an adjacent pile which is within 4 feet unless accepted in writing by the Engineer.
    3. Dip piles down to cut-off elevation while grout is still fluid. If required, place a metal sleeve in the top of each pile to become a permanent part of the pile.
    4. Distribute concentrated loads from equipment properly to prevent collapsing of the hole until mortar has set.
    5. Should any obstructions (including boulders or timbers) be encountered which prevent a pile from being installed to the desired depth at the design location, stop work on that pile until corrective measure instructions are received from the Engineer.
        a. Payment for piles partially completed or abandoned due to such obstructions will be adjusted at agreed Contract unit prices.
    6. Install piles to required tip elevation.

C. Mortar:
   1. Prepare mortar carefully in the proportions of accepted mix design.
      a. Inject mortar during withdrawal of auger maintaining minimum head of 15 feet of mortar above the injection tip to ensure lateral penetration and to prevent the hole from collapsing.
      b. Do not pump mortar until Soils Engineer has accepted the final tip elevation.
   2. Use only approved mixing and pumping equipment.
      a. Remove oil or rust inhibitors from mixer parts in contact with mortar prior to use.
      b. To produce a homogeneous mortar of the desired consistency, if there is a lapse in the operation of pumping, recirculate mortar through pump, mixer drum or agitator, and pump.
   3. Determine the quantity of grout pumped into each pile hole.
      a. Calibrate the mortar pump by pumping mortar into a 55-gallon drum.

D. Reinforcing:
   1. Install reinforcing, including dowels, as shown on Plans while the grout is in a fluid state.
      a. Field bending of dowels is not permitted unless specifically shown.
   2. Embed reinforcing to required depth before mortar has hardened.
      a. Extend tension-reinforcing bars in tension piles to bottom of pile.

E. Damaged or mislocated pile:
   1. Use piling procedures to avoid excessive or undue abuse.
   2. Repair or replace damaged piles, or piles located outside the required placing tolerances, at the direction of the Engineer.
   3. Install additional pile or piles where the pile centerline deviates from the specified tolerances and where a redesign indicates a load in any pile exceeding 110 percent of the design load.
   4. Piles rejected after installation may, when acceptable to Engineer be abandoned, cut off, and replaced by additional piles installed at new, designated locations indicated by a redesign accounting for the actual installed pile capacities and locations.
   5. All required redesign shall be at the Contractor's expense.

F. Tolerances:
   1. Pile installation tolerance shall be in accordance with ACI 117 and as follows:
      a. Plan location: Plus or minus 3 inches from location indicated for piles in a group, or plus or minus 1 inch from location indicated for individual piles, measured at the cut-off elevation.
      b. Plumbness: Deviation from plumb shall not exceed 2 percent of the pile length or one-half the edge-to-edge pile spacing, whichever is less.
      c. Top of pile horizontal deviation of the as-cast center shall be 4.2 percent of the pile diameter, or plus or minus 3 inches, whichever is less, measured from the center of tip.
      d. Elevation of pile tops: As specified on the pile schedule.
      e. After installation, a line from center of butt to center of tip shall be wholly within body of pile.
   2. Piles not conforming to the installation tolerances shall be reviewed by the Engineer prior to corrective measures being taken.

3.03 FIELD QUALITY CONTROL

A. Mortar testing:
   1. Test mortar in accordance with ASTM C109. Prepare a minimum of 6 cubes per day and test 2 cubes at 3 days, 2 at 7 days, and 2 at 28 days.
   2. Check each batch of grout with a USACE flow CRD-C79 cone having a 3/4-inch opening.
      a. Grout fluidity shall be such that the grout flows out of the cone in 17 to 25 seconds.

END OF SECTION

SECTION 32_01_15

PAVEMENT RESTORATION AND REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Resurfacing roads and paved surfaces in which surface is removed or damaged by installation of new work.

1.02 SUBMITTALS

A. Mix designs:
   1. Prior to placement of asphalt concrete, submit full details, including design and calculations for the asphalt concrete mix proposed.
   2. Submit gradation of aggregate base.
   3. Submit proposed mix design of portland cement concrete.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
   1. Limiting dimensions:
      a. Determine the exact lengths and dimensions of such roads, pavements, parking areas, and walks that will require removal and replacement for new work.
      b. Join existing surfaces to terminals of new surfacing in smooth juncture.

2.02 MATERIALS

A. Aggregate base course: As specified in Section 31_05_15 - Soil and for Earthwork.

B. Asphalt pavement: As specified in Section 32_12_15 - Asphaltic Concrete Paving.

C. Portland cement concrete replacement material: Class A concrete as specified in Section 32_16_13 - Concrete Sidewalks and Curb and Gutter.

2.03 EQUIPMENT

A. Roads, pavements, parking areas, and walks:
   1. Equipment requirements: Good condition, capable of performing work intended in satisfactory manner.

2.04 ACCESSORIES

A. Material for painting asphalt concrete pavement: Tack coat as specified in Section 32_12_15 - Asphaltic Concrete Paving.

PART 3 EXECUTION

3.01 INSTALLATION

A. Aggregate surface removal replacement:
   1. When trench cut is in aggregate surfaced areas, replace aggregate base course material with material matching existing material compacted to 95 percent of its maximum density.

B. Pavement removal and temporary asphalt replacement:
   1. Install temporary asphalt pavement or first course of permanent pavement replacement immediately following backfilling and compaction of trenches that have been cut through existing pavement.
   2. Except as otherwise provided, maintain this temporary pavement in safe and reasonably smooth condition until required permanent pavement is installed.
   3. Remove and dispose of temporary paving from project site.
   4. Where longitudinal trench is partly in pavement, replace pavement to original pavement edge, on a straight line, parallel to centerline of roadway.
   5. Where no part of longitudinal trench is in pavement, surfacing replacement shall only be required where existing surfacing materials have been removed.

C. Asphalt pavement replacement:
   1. Replace asphalt pavement to same thickness as adjacent pavement and match as nearly as possible adjacent pavement in texture, unless otherwise indicated on the Drawings.
   2. Cut existing asphalt pavements to be removed for trenches or other underground construction by wheel cutter, clay spade, or other device capable of making neat, reasonably straight and smooth cut without damaging adjacent pavement. Cutting device operation shall be subject to acceptance of Engineer.
   3. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement replacement, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt pavements. No extra payment will be made for these items, and costs incurred in performing this work shall be incidental to pipe laying or pavement replacement.
   4. Conform replacement of asphalt pavement to contour of original pavement.

D. Portland cement concrete pavement replacement:
   1. Where trenches lie within portland cement concrete section of streets, alleys, sidewalks, and similar concrete construction, saw cut such concrete (to a depth of not less than 1-1/2 inches) to neat, vertical, true lines in such manner adjoining surfaces are not damaged.

2. Place portland cement concrete replacement material to dimension as indicated on the Drawings.
3. Provide expansion joints that match existing.
4. Before placing replacement concrete, thoroughly clean edges of existing pavement and wash with neat cement and water.
5. Surface finish: Wood float finish.

E. Curb, gutter, and sidewalk replacement:
1. Where any concrete curb, gutter, or sidewalk has been removed or displaced, replace to nearest construction joints with new Class A curb, gutter, or sidewalk to same dimensions and finish as original construction that was removed:
a. Provide expansion joints of same spacing and thickness as original construction.

F. Asphalt pavements:
1. Trim existing asphalt pavements which are to be matched by pavement widening or pavement extension to neat true line with straight vertical edges free from irregularities with saw specifically designed for this purpose. Minimum allowable depth of cut shall be 1-1/2 inches.
2. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement widening or extension, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt concrete pavements.
3. No extra payment will be made for these items and costs incurred in performing this work shall be incidental to widening or pavement extension.

3.02 FIELD QUALITY CONTROL

A. Tests:
1. Asphalt concrete as specified in Section 32_12_15 - Asphaltic Concrete Paving.
2. Concrete as specified in Section 03_30_00 - Cast-in-Place Concrete.

B. Inspection:
1. Asphalt concrete:
a. Lay 10-foot straightedge parallel to centerline of trench when the trenches run parallel to street, and across pavement replacement when trench crosses street at angle.
b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.
2. Portland cement concrete replacement pavement:
a. Lay 10-foot straightedge either across pavement replacement or longitudinal with centerline of gutter or ditch.
b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.

END OF SECTION

SECTION 32_12_15

ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Asphalt concrete pavement on prepared subgrade or aggregate base course, and on existing pavement, to lines, grades, compacted thicknesses, and cross sections indicated on the Drawings.
   2. The work specified in this section includes the construction of hot mix asphalt (HMA) paving as indicated on the Plans in within this Specification. This section also includes temporary asphalt cold-mix for temporary repairs.
   3. Work shall also include the restoration of all asphalt surfaces excavated or disturbed during construction to a condition acceptable to the Owner.
   4. The work in this section shall be accomplished in accordance with the Standard Specifications for Road, Bridge and Municipal Construction, 2024 edition, as issued by the Washington State Department of Transportation (WSDOT) and the American Public Works Association (APWA), Washington State Chapter (hereafter “Standard Specifications”). The Standard Specifications, as modified or supplemented by the Amendments to the Standard Specifications and Technical Specifications shall govern the Work.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Transportation Materials and Methods of Sampling and Testing:
      a. MP1: Specification for Performance Graded Asphalt Binder.

B. ASTM International (ASTM):
   1. C117 - Standard Test Method for Material Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D977 - Standard Specification for Emulsified Asphalt.
   5. D2041 - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
   6. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

C. Washington State Department of Transportation (WSDOT):
   1. Standard Specifications (Standard Specifications).

D. “Geotechnical Design Services – Post Point Sludge Tank Replacement” by GeoEngineers, dated December 19, 2024. This report summarizes geotechnical site explorations, design, and construction recommendations.

E. City of Bellingham Development Guidelines and Improvements Standards.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Bituminous Prime Coat: Consist of application of hot bituminous material on previously prepared base course.

1.04 SUBMITTALS

A. Proposed mix design and gradation of materials.

B. Quality control Submittals:
   1. Certificate of Compliance. The certificates shall be provided to the Owner at least 5 consecutive calendar days prior to placement of any materials.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Asphalt concrete delivery:
   1. Transport the mixture from the mixing plant to the point of use in vehicles having tight bodies previously cleaned of foreign materials.
   2. Treat bodies as necessary to prevent material from sticking to the bodies.
   3. Cover each load with canvas or other suitable material of sufficient size and thickness to protect the asphalt mixture from the weather.

B. Comply with Standard Specifications storage requirements, if applicable.

1.06 PROJECT CONDITIONS

A. Environmental requirements:
   1. Asphalt concrete:
      a. Place only when surface is dry, and when atmospheric temperature in the shade is 40 degrees Fahrenheit and rising, or above 50 degrees Fahrenheit if falling.
      b. Do not place when weather is foggy or rainy or when base on which material is to be placed is in wet or frozen condition.
   2. Prime coat:
      a. Do not apply when atmospheric temperature is below 60 degrees Fahrenheit.
      b. Apply only when base course is dry or contains moisture not in excess of that which will permit uniform distribution and desired penetration.

1.07 SEQUENCING AND SCHEDULING

A. Prime coat:
   1. Prior to requesting Engineer's acceptance for application, inspect area to be coated to determine its fitness to receive bituminous priming material.
   2. Do not begin application before area to be coated has been accepted for application by the Engineer.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
   1. Compact the asphalt concrete to at least 95 percent of the density of the theoretical maximum density in accordance with ASTM D2041.

2.02 MATERIALS

A. Subgrade material: Stabilization material as specified in Section 31_05_15 - Soils and Aggregates for Earthwork.
   1. Thickness: As indicated on the Drawings.
   2. Maximum lift thickness: 4 inches.
   3. Compaction: Minimum 98 percent of the AASHTO T-180 maximum dry density.

B. Base material: Aggregate base course material as specified in Section 31_05_15 - Soils and Aggregates for Earthwork.
   1. Thickness: As indicated on the Drawings.
      a. Maximum lift thickness: 4 inches.
   2. Compaction: Minimum 98 percent of the AASHTO T-180 maximum dry density.

C. Prime coat:
   1. Use bituminous material in accordance with Standard Specifications.
   2. Apply at temperature of 105 to 175 degrees Fahrenheit at rate of 0.3 to 0.6 gallons per square yard by use of bituminous distributor.

D. Sand: Acceptable to the Engineer.

E. Tack coat: Use bituminous material in accordance with Standard Specifications.

F. Asphalt concrete materials:
   1. Asphalt cement: Conform to requirements for asphalt cement, PG 64-28 AASHTO MP1.
   2. Mineral aggregate:
      a. Consist of coarse aggregate of crushed stone or gravel composed of hard, durable particles, sand, and filler as follows:
         1) Coarse aggregate: Portion of material retained on Number 8 sieve.
         2) Fine aggregate: That portion passing Number 8 sieve.
      b. Provide composite material that is uniformly graded from coarse to fine and that complies with requirements of one of the following gradings when tested in accordance with ASTM C136.

c. As indicated on the Drawings, 2-course plant mix for asphalt concrete having an overall thickness of 2 1/2 inches or more if not indicated. If less than 2-1/2 inches of asphalt concrete, use single-course plant mix.

Plant Mix, Two Course				Plant Mix, Single Course	
Seal, 3/4-inch Thick Minimum		Base, 1-3/4-inch Thick Minimum		1-1/2-inch Thick Minimum	
Sieve Size	Percent Passing	Sieve Size	Percent Passing	Sieve Size	Percent Passing
1/2”	100	1-1/4”	100	3/4”	100
3/8”	95 - 100	1”	87 - 100	1/2”	75 - 95
No. 4	50 - 70	3/4”	75 - 90	3/8”	65 - 85
No. 8	35 - 55	3/8”	55 - 72	No. 4	50 - 65
No. 30	15 - 30	No. 4	40 - 60	No. 8	35 - 50
No. 100	5 - 15	No. 8	30 - 50	No. 30	15 - 30
No. 200	3 - 8	No. 30	15 - 30	No. 100	5 - 15
		No. 100	5 - 15	No. 200	3 - 8
		No. 200	3 - 8		

3. Coarse aggregate:
   a. Consist of at least 70 percent by weight of each size aggregate and consist of particles that have at least one rough, angular surface produced by crushing:
      1) Have percentage of wear of not more than 50 at 500 revolutions, in accordance with ASTM C131.
   b. Aggregate plasticity index: Not more than 2 in accordance with ASTM D4318.
   c. Sand may be added to crusher or pit-run product to supply any deficiency in Number 8 sieve and filler may be added to supply any deficiency in Number 200 sieve material. If aggregate contains an excess of sand, wasting will be required.
   d. Filler:
      1) Use finely powdered limestone, Portland cement, or other artificially or naturally powdered mineral dust acceptable to the Engineer.
      2) Weigh filler and add separately to each batch at time of proportioning.
      3) Use filler that is free from deleterious matter of any kind.
      4) Fineness that meet the following requirements:
         a) Passing Number 50 sieve: 100 percent.
         b) Passing Number 200 sieve: At least 75 percent.
      5) Determine amount of material passing the Number 200 sieve in accordance with ASTM C117.
   e. Provide composite aggregate that is free from vegetable matter, lumps or balls of clay, adherent films of clay, or other matter which would prevent thorough coating of asphalt cement.
   f. Materials derived from processing demolished, or removed asphalt concrete, are not acceptable.

G. Fog sealing: Asphalt emulsion, Grade SS-1h.

2.03 COLD MIX TEMPORARY REPAIR

A. Cold-mix material shall be MC-2 asphaltic concrete commonly referred to as “cold-mix”.

2.04 EQUIPMENT

A. Bituminous distributor: Designed and equipped so as to distribute bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rate with pressure range of 25 to 75 pounds per square inch.

B. Liquid asphalt distributor:
   1. Designed and operated to distribute asphaltic material in uniform spray without atomization.
   2. Equipped with bitumeter having dial registering feet of travel per minute.
      a. Locate dial so that it is visible to truck driver so that he can maintain constant speed required for application at specified rate.
   3. Equip pump with tachometer having dial registering gallons per minute passing through nozzles.
      a. Locate dial so that it is readily visible to operator.
   4. Provide means for accurately indicating temperature of asphaltic material in distributor at all times.
      a. Locate thermometer well so that it is not in contact with, or close to, heating tube.
   5. Have spray bar having normal width of application of not less than 12 feet and capable of providing for application of lesser width when necessary.
   6. Provided with hose and spray nozzle attachment for applying asphaltic material to patches and areas inaccessible to spray bar.
   7. Equipped with heating attachments and capable of circulating asphaltic material through spray bar during entire heating process.

C. Asphalt concrete mixing plants:
   1. Equipment:
      a. Use screen and storage bins at plant of sufficient capacity to furnish the necessary amount of aggregates, when operating at the maximum capacity of the plant, with no periods of undue waiting for material.
         1) Use bins consisting of at least 2 compartments, so proportioned as to ensure adequate storage of appropriate fractions of the aggregate.
         2) Provide each compartment with an overflow pipe of such size and at such location as to prevent any backing up of material into other compartments.
      b. Dryer:
         1) Designed to heat and dry the aggregate to Specification requirements and to agitate it continuously during the heating.
         2) Capable of preparing aggregates at a rate equal to the full-rated capacity of the plant.
      c. Dust collector:
         1) So constructed as to waste or return uniformly to the hot elevator all or any part of the material collected.

d. Mixer:
    1) Adequate capacity, with twin shafts.
e. Thermometers:
    1) Furnished for determining the temperature of the mix.
f. Weighing and measuring equipment:
    1) Weighing or volumetric measuring equipment of sufficient capacity.
    2) Devices to permit easy readjustment of any working part needing readjustment, so that the equipment will function properly and accurately.
    3) Attach scales for weighing to the bucket.
    4) Test and seal weighing equipment by a representative of the Inspector of Weights and Measures having jurisdiction, as often as the Engineer may deem necessary to ensure accuracy.
g. Tanks for storage of bituminous material:
    1) Capable of heating the material under effective and positive control at all times to temperatures within the range stipulated.

2. Asphalt concrete plant operation:
    a. Mineral aggregate:
        1) Dry and heat mineral and then screen into at least 2 fractions and conveyed into separate compartments ready for proportioning and mixing.
        2) When combined with asphalt cement.
    b. Aggregate:
        1) Contain not more than 2 percent moisture by weight.
        2) Be at a temperature within the range of that specified for the asphalt cement but not more than 25 degrees Fahrenheit above the temperature of the asphalt cement.
    c. Combine dry aggregate in the plant in the proportionate amounts of each fraction of aggregate required to meet the specified grading.
        1) Introduce the asphalt cement into the mixer in the amount and at the temperature for the particular material being used.
        2) Continue mixing for at least 30 seconds, and for such longer period as may be necessary to coat the particles.
    d. When a continuous mixer is used, determine the mixing time by weight method using the following formula:
        1) Mixing time in seconds = Pugmill dead capacity in pounds.
        2) Pugmill output in pounds per second.

D. Asphalt-concrete-placing equipment:
    1. Use equipment for placing, spreading, shaping, and finishing asphalt concrete consisting of a self-contained power machine operating in such manner that no supplemental spreading, shaping, or finishing is required to provide surface that complies with requirements for smoothness contained in this Section.
        a. In areas inaccessible to the machine, hand spreading may be permitted.
    2. Furnish 1 self-propelled, pneumatic-tired roller, and one 8-ton (minimum), smooth-wheel tandem roller.
        a. When spreading is in excess of 100 tons per hour, furnish 1 additional roller of either type for each additional 100 tons, or fraction thereof, spread per hour.

2.05 MIXES

A. Asphalt cement:
   1. Do not mix at temperatures lower than 275 degrees Fahrenheit or higher than 325 degrees Fahrenheit.
   2. Usual amount of asphalt cement, by weight, to be added to aggregate be 5.4 to 5.8 percent of weight of mixture.

B. Asphalt concrete:
   1. Before being delivered to the site, mix aggregate with asphalt cement at the central mixing plant.
   2. Use mixing plants that are in good working order with no excessively worn parts and so equipped that:
      a. Temperatures of aggregates leaving dryer, of asphalt cement entering mixer, and of mix leaving mixer can be readily determined and positively controlled within Specification limits at all times.
      b. Weights of different sizes of aggregates and of asphalt cement as set by the Engineer can be consistently introduced into the mixer.
      c. Asphalt cement can be uniformly distributed throughout the mixture with aggregate completely coated.
      d. Mixing time can be positively controlled to minimum specified.
      e. Bin samples of aggregate can be readily obtained.
      f. Provide means of calibrating weighing devices.

PART 3 EXECUTION

3.01 PREPARATION

A. Protection:
   1. Prime-coated surfaces:
      a. Maintain surfaces until succeeding layer of pavement has been placed.
      b. During this interval, protect primed surfaces against damage and repair any broken spots.

B. Surface preparation:
   1. Prime coat:
      a. Where portions of base course prepared for immediate treatment are excessively dry, sprinkle such portions lightly with water immediately in advance of prime coat application.
      b. Immediately following preparation of base course, apply bituminous material by means of bituminous distributor at the temperature previously specified.
      c. Apply priming material in manner that results in uniform distribution being obtained at all points of surface to be primed.
      d. Following the application of prime material, allow the surface to dry for a period of not less than 48 hours without being disturbed, or for such additional period of time as may be necessary to obtain penetration into the base course and drying out or evaporation of the volatiles from prime material.
      e. Spread sufficient sand on areas that show an excess of bituminous material to effectively blot up and cure the excess.

2. Base courses:
    a. Thoroughly clean base and apply prime coat before placing asphalt concrete.
    b. Thoroughly clean any existing base, surfacing, or pavement prior to placing plant-mixed surfacing.
    c. Where existing pavement is being widened or extended, cut to straight vertical face and treat with asphalt paint binder prior to paving operations.
    d. When asphalt concrete is to be applied over existing pavement and local irregularities in existing surface would result in course of more than specified thickness, bring surface of existing pavement to uniform contour by patching with asphalt concrete thoroughly tamped or rolled until it conforms with surrounding surface, and then apply tack coat.

3.02 APPLICATION

A. At existing asphalt to be paved over: Apply tack coat at minimum rate of 0.10 gallons per square yard.

B. Placing and compacting asphalt concrete:
    1. Placing and compacting asphalt mixture: Progress in sections generally not more than 750 linear feet in length.
    2. Spreading of mixture:
        a. Spread, shape, and finish by specified equipment.
        b. Spread each successive strip adjacent to previously spread strip.
        c. Do not compact minimum 6-inch width of each strip adjacent to new strip until after new strip has been placed.
        d. Spread as nearly continuous as possible.
        e. Laying against vertical surfaces such as gutters: Roughen and clean face of vertical surfaces as required for proper bonding and then paint with light coating of asphalt cement or emulsified asphalt.
        f. At terminations of new surface courses: Feather asphalt mixture into existing surface over such distance as may be required to produce smooth riding transition.
        g. Base-course and single-course construction: Joined by vertical butt joints, finished and rolled to smooth surface.
        h. Rolling:
            1) Perform initial or “breakdown” rolling with tandem power roller and follow spreading operation when mixture has reached temperature where it does not “pick up” on rolls.
            2) Keep rolls properly moistened but do not use surplus of water.
            3) Follow initial rolling with pneumatic roller when mixture is in proper condition and when rolling does not cause undue displacement, cracking, or shoving.
            4) Begin rolling at sides and progress gradually to center, lapping each preceding track until entire surface has been rolled.
            5) Terminate alternate trips of roller in stops at least three feet distant from any preceding stop.
            6) At any place not accessible to roller, thoroughly compact mixture with tampers and finish, if necessary, with hot iron to provide uniform layer over entire width being paved.
    3. Provide finish surface having uniform texture.

C. Fog sealing:
    1. After compaction with fog sealing material applied at rate of 0.05 gallons per square yard at the following locations:
        a. Asphalt pavement.

D. Full-depth asphalt pavement:
    1. Contractor's option:
        a. Install either asphalt and aggregate base material or full-depth asphalt pavement in areas where paving is indicated on the Drawings or specified to be 2 inches of asphalt concrete over aggregate base course.
        b. If option is selected to install full-depth asphalt pavement, prepare subgrade as previously specified in this Section.
        c. Substitute asphalt concrete for aggregate base at ratio of 1 inch of asphalt concrete to 2-1/2 inches of aggregate base material. Use full-depth asphalt pavement not less than 4 inches in thickness after compaction.
        d. Place asphalt concrete in courses of not more than 4 inches.
        e. Use compaction equipment in accordance with following course thicknesses:
            1) 1- to 2-inch thickness: Minimum 8-ton roller.
            2) 2- to 3-inch thickness: Minimum 10-ton roller.
            3) 3- to 4-inch thickness: Minimum 12-ton roller.
    2. Pneumatic rollers used for initial or secondary rolling: Use 12 to 15 tons with tires capable of 90-pounds-per-square-inch inflation pressure.
    3. Asphalt concrete for full-depth asphalt pavement:
        a. Asphalt concrete as previously specified in this Section.
        b. Apply bituminous prime coats where full-depth asphalt pavement is installed.
        c. Contractor's option: If Contractor elects to use full-depth asphalt pavement, at road shoulders reduce aggregate base course to minimum aggregate thickness of 4 inches.
    4. Except for asphalt thickness, aggregate base course thickness, and prime coating, full-depth asphalt pavement shall comply with requirements of this Section.

E. Asphalt joints
        a. All joints of hot mix asphalt pavement shall be sealed with hot poured sealant meeting the requirements of WSDOT Standard Specification 9-04.2

F. Cold Mix Temporary Repair
    1. During the course of construction, it may be necessary to provide temporary vehicle and/or pedestrian access within the project limits. Such temporary access shall be provided by temporarily patching trench crossings or other areas with cold mix, until such time as the permanent surface restoration is installed. Locations shall include those areas specifically indicated on the Plans, directed by the Owner or as further specified herein. This material will be furnished, placed, compacted, and removed and waste hauled at various locations throughout the project. The trenches and/or subgrade shall be thoroughly compacted and brought to a smooth grade prior to placing the material. It shall be placed, maintained (daily), and removed and waste hauled by the Contractor. Provide a minimum compacted thickness of 2 inches.

3.03 SAWCUTTING

A. Where shown on the Plans or where directed in the field by the Owner, the Contractor shall make a neat vertical sawcut at the boundaries of the area to be removed. Care shall be taken during sawcutting so as to prevent damage to the existing asphalt concrete, or concrete, to remain in place. Any pavement or concrete damaged by the Contractor outside the area scheduled for removal due to the Contractor's operations or negligence shall be repaired or replaced to the Owner's satisfaction by the Contractor at no additional cost to the Owner.

B. All cuts shall be continuous, full depth, and shall be made with saws specifically equipped for this purpose. No skip cutting, wheel cutting or jack hammering will be allowed unless specifically approved otherwise in writing by the Owner.

C. However, even if preapproved as a method of cutting, no payment will be made for this type of work, and it shall be considered incidental and included in the various unit contract and lump sum prices listed in the Proposal.

D. The location of all pavement cuts shall be preapproved by the Owner in the field before cutting commences.

E. All water and slurry material resulting from sawcutting operations shall not be allowed to enter the storm drainage or sanitary sewer system and shall be removed from the site and disposed of in accordance with the Washington State Department of Ecology regulations.

F. All existing asphalt concrete pavement edges shall be saw cut back to sound material, in uniform lines immediately prior to paving operations. Any edges broken between the time of cutting and placement of new paving shall be recut to the satisfaction of the Owner at no additional cost to the Owner. All excess excavated materials shall be hauled to waste.

3.04 ASPHALT TRENCH PATCH

A. This work shall consist of the preparation, placing and compaction of asphalt trench sections, in accordance with the details included on the plans and the requirements outlined herein. The work shall be in conformance with this specification unless specifically directed otherwise by the Owner.

B. The Contractor shall restore all asphalt surfaces excavated or disturbed to a condition acceptable to the Owner.

C. Before any HMA material is placed, all pavement cuts shall be trued so that marginal lines of the patch will form a rectangle with straight edges and vertical faces a minimum of 1 foot back from the maximum trench width.

D. The asphalt shall be placed and compacted in lifts that are no thinner than 2-inches. The asphalt trench patch thickness shall match existing asphalt thickness or the minimum pavement repair section indicated on the plans whichever is thicker.

E. Seal all joints scheduled to not receive an asphalt overlay.

3.05 ADJUSTING STRUCTURES TO GRADE

A. All utility castings and monuments within the existing and/or new pavement area shall be referenced by the Contractor prior to any pavement removal or planning. The Contractor shall keep a record of such references, and submit a copy to the Owner.

B. Existing structures and new structures shall be adjusted to the finished grade as shown on the Plans and as further specified herein. Existing boxes, rings, grates, covers, and lids shall be reset in a careful and workmanlike manner to conform to the required grades.

C. The new and existing utility castings and monuments shall be adjusted to grade in the following manner:

D. As soon as the street or driveway has been paved past each structure or casting, the asphalt concrete mat shall be scored around the location of the structure or casting. After rolling has been completed and the mat has cooled, it shall be cut along the scored lines. The structure or casting shall then be raised to finished pavement grade and the annular spaces filled as indicated on the Plans. The Contractor shall install the pavement to give a smooth finished appearance. All covers, lids, frames, and grates shall be thoroughly cleaned.

E. After pavement is in place, all new pavement joints shall be sealed with a 6-inch wide strip of hot asphalt sealer. A sand blanket shall be applied to the surface of the hot asphalt sealer immediately after the placement of the sealer to help alleviate the tracking of the asphalt. The sealer shall meet the requirements of Section 9-04.2 of the WSDOT Standard Specifications.

3.06 FIELD QUALITY CONTROL

A. Base course density tests:
   1. Taken at locations suitable to confirm compliance with compaction requirements.
   2. Take a minimum of 1 test per 1,000 square yards for each lift.

B. Placement:
   1. Place the mixture on the roads, pavements, or walks at a temperature not less than 225 degrees Fahrenheit.

C. Curing time:
   1. Allow asphalt concrete to cure for the following time periods:
      a. Minimum 24 hours before foot traffic is allowed.
      b. Minimum 5 days before vehicle traffic is allowed.
      c. Minimum 10 days before overnight parking is allowed.
      d. Minimum 20 days before heavy construction vehicle traffic is allowed.
   2. Provide barricades and signs as required to enforce curing time.

D. Asphalt tests:
    1. Provide sampling and control testing for the asphalt concrete.
        a. Location, type, and size of the samples: Suitable to determine conformance with stability, density, thickness, compaction, and other specified requirements.
        b. Use an approved power saw or core drill for cutting samples.
        c. Furnish tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed.
        d. Take a minimum of 1 sample per 200 tons of asphalt concrete placed.

E. Inspection:
    1. Asphalt concrete:
        a. Test with a 10-foot straightedge laid on the surface parallel with the centerline of the road. Variation of the surface from the testing edge of the straightedge not to exceed 1/4 inch.
        b. Test each course with running water applied on the surface of the pavement. Water shall flow in the direction indicated on the Drawings. After stopping the water, the pavement surface shall have no areas with standing water.

END OF SECTION

SECTION 32_16_13

CONCRETE SIDEWALKS AND CURB AND GUTTERS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Work includes but is not limited to following: Provide all material, labor, and equipment for the construction of cement concrete curbs, curbs and gutters, gutters, spillways, asphalt concrete curbs, gutters, and spillways of the kind and design specified, at the locations shown in the Plans in accordance with these Specifications and in conformity to the lines and grades as staked by the Contractor's surveyor. Provide all material, labor, and equipment for constructing cement concrete sidewalks in accordance with the requirements set forth in these specifications and as depicted on the Plans. Truncated domes on all sidewalk ramps.

B. Related Documents/References:
   1. Coordinate related work specified in other parts of the Project Manual.
   2. Section 31_00_00 - Earthwork.
   3. WSDOT Standard Specifications for Road, Bridge and Municipal Construction, 2025 Edition.
   4. City of Bellingham Development Guidelines and Improvement Standards.
   5. Washington Department of Ecology August 2024 Edition, Stormwater Management Manual for Western Washington (SWMMWW)
   6. "Geotechnical Design Services - Post Point Sludge Tank Replacement" by GeoEngineers, dated December 19, 2024. This report summarizes geotechnical site explorations, design, and construction recommendations.

1.02 QUALITY ASSURANCE

A. Manufacturer/Installer shall be a Specialist.

B. Testing and Inspection. Owner will provide independent testing and inspection outside of the contract. Contractor shall coordinate and cooperate with Owner's independent testing and inspection agency which will perform the following tasks:
   1. Compaction and Moisture Control Tests on foundation subgrade prior to placement reinforcing.
   2. Reinforcing placement, lap length, and bar sizes.
   3. Owner will provide quality assurance testing to verify compressive strength and air entrainment.

1.03 SUBMITTALS

A. For all materials to be incorporated into the project the Contractor shall provide a Request for Approval of Material (RAM) on the WSDOT RAM form. Contractor must have approval from the Engineer of Record (Engineer) prior to incorporating materials into project. A separate RAM form shall be provided for dissimilar

materials or materials that are not part of the same assembly. The RAM must clearly indicate where the product is intended to be used and shall include spec reference and/or plan sheet reference. Any approvals granted for use of materials will be limited to those uses identified on the RAM form. Any materials incorporated into the project without an approved RAM may be removed at the request of the Engineer at the contractor's expense.

B. RAMs are required for the following:
   1. Cement Concrete Mix design.

PART 2 PRODUCTS

2.01 GENERAL

A. Comply with "Quality Assurance" provisions, "References," and Specifications. Where these may be in conflict, the more stringent requirements govern.

2.02 MATERIALS

A. Portland Cement Concrete shall be Class 3000, 6 percent air entrained, minimum cement content 564 pounds per cubic yard of concrete content per WSDOT Section 6-02.3(2)B, or City of Bellingham Development Standard "Class C Concrete." Fly ash content shall be 35 percent minimum (minimum 5 percent post-consumer). Mix design shall be in accordance with WSDOT Section 5-05.3. Include computation/derivation of conversion factor of flexural strength to compressive strength based on actual tests. Mix design, test results, and supporting documents can be from recent concrete jobs.

B. Premolded Joint Filler. Pro-Flex manufactured by Oscoda, or approved; 100 percent recycled vinyl.

C. Joint Sealant shall be per WSDOT 9-04.2.

D. Aggregate Base Materials
   1. Sidewalks, Minimum 2-inch depth of 3/4-inch washed rock base per City of Bellingham Standard Drawing CG-230.

E. Detectable Warning Strips at Sidewalk Ramps. Per WSDOT Standard Specification 8-14.3(5) and City of Bellingham Standard Drawing CG-246.

PART 3 EXECUTION

3.01 GENERAL

A. Verify installation conditions as satisfactory to receive work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 INSTALLATION

A. Install in accordance with “Quality Assurance” provisions, “References,” and Specifications. Where these may be in conflict, the more stringent requirements govern.

B. General. The foundation for curbs, gutters, and spillways shall be thoroughly compacted and required side forms shall rest throughout their length on firm ground.

C. Formwork. Side forms for straight sections shall be full depth of the curb. They shall be either metal of suitable gage for the work or surfaced “construction” grade lumber not less than 2 inches (commercial) in thickness. Forms used more than one time shall be thoroughly cleaned and any forms which have become worn, splintered, or warped shall not be used again.

D. Placement and Finish. The foundation shall be watered thoroughly before the concrete is placed, and the concrete shall be well tamped and spaded or vibrated in the forms. The exposed surfaces shall be finished full width with a trowel and edger. Within 24 hours after the concrete is placed, the forms of the roadway face of curbs shall be removed, and the concrete treated with a float finish. The top and face of the curb shall receive a light brush finish, and the top of the gutter shall receive a broom finish. Joints in the curb and gutter shall be spaced to match joints in the abutting pavement.

E. Joints.
   1. If the abutting pavement is not jointed or the curb or gutter is not abutting pavement, joints in the curb and gutter shall be spaced at 15-foot intervals. These joints shall be 1/8-inch minimum thickness and constructed to a minimum depth of 1-inch by sawing or scoring with a tool which will leave the corners rounded and destroy aggregate interlock to a depth specified for sawing at the joint.
   2. Expansion joints filled to full cross-section with filler 1/4-inch thick shall be placed in the curb and gutter to match joints in the abutting pavement, at bridges, drainage structures, curb returns, and where shown in the Standard Plans. The concrete shall be cured for 72 hours by one of the methods specified for cement concrete pavement in WSDOT Standard Specification 5-05.

F. Slip Form. At the option of the Contractor, the curb and gutter may be constructed using approved slip-form equipment. The curb and gutter shall be constructed to the same requirements as the cast-in-place curb and gutter.

G. Subgrade.
   1. Prepare subgrade by grading lines, grades, and dimensions indicated in the plans. Allow for specified thickness of base course and concrete sidewalk so as to achieve specified finished grades and slopes. Fill and/or cut as necessary to achieve specified finished grades.
   2. Compact subgrade to 95 percent of maximum density prior to placement of base course.

H. Base Course.
   1. Place minimum 2-inch gravel base to lines and grades indicated in the plans. Allow for specified concrete thickness.
   2. Compact base course to 95 percent maximum density.

I. Concrete.
   1. Sidewalk surface finish near existing sidewalks to match existing sidewalk in texture and color to the maximum extent possible, unless noted otherwise. If not in conflict with existing sidewalk finish to be matched, new sidewalk shall have broom finish, unless noted otherwise, perpendicular to direction of travel with continuous smooth trowel edges. Smooth trowel edges of all slabs. Where new sidewalk apron sections adjoin existing sidewalks, mate top surfaces flush. Align edges and corners to create smooth linear and angular transitions with neat lines and appearance. Slope finished surfaces of sidewalks to drain freely and away from any adjacent structures. Slope at 1/4-inch per foot.
   2. Expansion/Control Joints for Sidewalks (City of Bellingham Development Standards apply): Provide 3/8-inch by 2-inch sidewalk expansion joints at 10 feet, 0-inches O.C. and/or in configuration to match and continue with pattern of existing walkways. Crack control joints shall be provided at 5 feet, 0-inches O.C., alternated with sidewalk expansion joint placement, resulting in a 5 feet, 0-inches O.C. joint spacing pattern. Provide expansion joints at all joints between new and existing concrete surfaces. Install preformed joint filler material recessed from slab surface to allow for sealant bead. Place joint sealant on all joints, flush with concrete surface. No projections will be accepted.

3.03 ADJUSTING, CLEANING, AND REPLACEMENT

A. Make any adjustments as required.

B. Clean: Leave installations clean; premises free from residue of work of this section.

END OF SECTION

SECTION 32_90_01

LANDSCAPING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Work in this section shall include all labor, equipment and materials necessary for re-establishing grass in areas disturbed during construction and as indicated on the drawings. Work shall include stripping, excavation, hauling, stockpiling, placing topsoil, placing compost, and seeding.

1.02 RELATED SPECIFICATIONS

A. Section 31_00_00 - Earthwork.

B. Section 31_32_11 - Soil Surface Erosion Control.

1.03 SEEDING GUARANTEE

A. During the one (1) year guarantee period should any seeded area show signs of failure such as dead or dying areas of grass, bare spots, etc., the Contractor shall repair or replace all deficient items to the satisfaction of the Engineer.

B. All graded areas not seeded or paved shall be covered with two (2) inch depth straw to prevent erosion. Straw to be provided and installed by the Contractor. Do not perform planting or seeding when ground is frozen, snow covered, muddy or in an otherwise unsatisfactory condition. When unforeseen conditions detrimental to plant growth are encountered, such as adverse drainage conditions, obstructions, compaction, or toxified soils, notify the Engineer before proceeding.

1.04 SUBMITTALS

A. The Contractor shall submit product specifications and installation recommendations for all materials to be provided under this section.

B. Submit seed vendor’s blue tag certification for required grass seed mixture, indicating percentage by weight, and percentages of purity, germination, and weed seed for each grass species.

C. Upon seeded areas acceptance, submit written maintenance instructions recommending procedures for maintenance of seeded areas.

PART 2 PRODUCTS

2.01 TOPSOIL MATERIAL

A. Topsoil shall conform to Section 9-14.2 of the WSDOT Standard Specifications.

2.02 GRASS SEED

A. Seed shall conform to Table 1. Seed of the following composition, proportion, and quality shall be applied at a rate of 8 pounds per 1000 square feet:

Table 1	
Common Name	**% by Weight**
Perennial Ryegrass	60
Chewings Fescue	20
Creeping Red Fescue	20

B. The seed mixture shall adhere to Section 9-14.3 of the WSDOT Standard Specifications and seed types shall be certified in accordance with WAC 16-302.

2.03 FERTILIZER

A. Fertilizer shall be a granular, non-burning product composed of not less than 50 percent organic, slow acting, guaranteed analysis professional fertilizer. Seeded area starter fertilizer containing 20 percent nitrogen, 26 percent phosphoric acid, and 6 percent potash by weight, or similar approved composition applied at a rate of 6.5 lbs/1000 sq. ft.

2.04 WOOD FIBER MULCH FOR HYDRO-SEEDING

A. Hydro-seeding to be applied to all areas disturbed and/or regraded (which will not be protected with quarry spalls, gravel, and/or pavement) during construction. Commercially prepared wood fiber mulch specifically manufactured for hydro-seeding application shall be used.

B. Dispersing agents may be added at Contractor's option provided that the additive is not harmful to the mixture.

2.05 WATER

A. The Contractor shall furnish water per Section 01_50_00 - Temporary Facilities and Controls as required for planting and establishing vegetation in seeded areas and planting shrubs and trees. Provide all necessary hoses, equipment, attachments, and accessories for adequate watering of seeded areas.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall notify the Engineer 48 hours in advance of hydroseeding operations and shall not begin the work until areas prepared or designated for seeding have been approved.

B. The Contractor shall hydroseed all disturbed areas and planting areas as shown in the plans. All planting areas shall receive upland seed mix.

C. Disturbed areas where hydroseeding is impractical may be seeded by hand with Engineer approval. When hand seeding, the seed shall be incorporated into the top 1/4-inch of soil by hand raking or other method approved by the engineer.

D. Protect seed during germination in conformance with the WSDOT Standard Specifications, Section 8-02.3(13).

3.02 SEEDING

A. Inspect all subgrades for debris and adverse drainage conditions. Remove all debris including rocks 1-inch in diameter and larger, sticks, roots, sod and other deleterious material. Notify the Owner of any grades or conditions which might create adverse or undesirable drainage patterns.

B. Smoothly blend and feather topsoil into existing surrounding grades. Rake or lightly harrow topsoil until the soil is friable and of uniform texture and satisfactory for seed placement.

C. After seeding, topsoil shall be rolled for compaction and shall be minus 1/2-inch below all adjacent paved or graveled surfaces. Irrigate immediately until soil is damp to about 6-inches.

D. The hydro-seeding operation shall include the installation of seed, fertilizer, mulch, and tackifier with a tracer to verify uniform application.

E. Hydro-seeding shall be done in accordance with WSDOT Spec. 8-01.3(2)B.

F. Seed immediately after preparation of seed bed. Seeding may occur August 15 to October 15.

G. Seed shall be applied at a rate listed above.

H. Mulch shall be applied at a rate of 2,000 pounds per acre.

3.03 MAINTENANCE AND WATERING

A. Water regularly until germination is consistent and the seedlings are averaging 1-inch in height, then reduce to less frequent intervals (but maintain appropriate soil moisture to ensure proper growth).

B. Re-seed, approximately 21 days after germination, any barren area 12-inches in diameter or larger, at the specified application rate. In the event of unusual weather, over-seed when weather conditions are suitable for germination, at rate determined by Engineer (not to exceed original rate.)

C. Apply fertilizer rate as follows: first application not earlier than 4 weeks, but not to exceed 6 weeks after installation; second application 4-6 weeks after first application, but not to exceed 10 weeks after installation.

D. Patch, repair and re-seed any and all damaged or barren areas observed prior to final project acceptance at no additional cost to the Owner.

E. The Contractor shall protect and care for all seeded areas until fully established and hearty. Care shall include equipment and labor necessary to provide sufficient and continuous watering of all seeded areas until final acceptance.

3.04 FINAL ACCEPTANCE

A. Final acceptance of seeded areas shall be based on a uniform stand of grass free of weeds, pests, and diseases as determined by Engineer.

END OF SECTION

SECTION 33_05_61.02

PRECAST REINFORCED POLYMER CONCRETE MANHOLES AND VAULT STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for precast reinforced polymer concrete manholes and vault structures.
   2. Requirements govern both manholes and vaults structures, unless specified otherwise.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. C33 - Standard Specification for Concrete Aggregates.
   3. C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
   4. C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
   5. C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
   6. C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   7. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   8. C923 - Standard Gide for In-Plant Performance Evaluation of Automatic Pedestrian SNM Monitors.
   9. C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Performed Flexible Joint Sealant.
   10. C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
   11. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in Edgewise Position.
   12. D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.

C. International Organization of Standardization (ISO):
   1. 9001 - Quality Management Standard.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Manufacturer certification showing that acid resistant polymer manhole design meets or exceeds the load and strength requirements in accordance with ASTM C478, ASTM C497, and ASTM C857.
   2. Test methods and results including certification that manhole riser exceeds the minimum requirements in accordance with ASTM C478 and ASTM C579, including:
      a. Concrete cylinder compression test results.
   3. Certificates:
      a. ISO 9001 certificate by a third party confirming that ASTM test reports are valid and up to date at the time of the bid and during construction period.
      b. Manufacturer's Certificate of Source Testing.
   4. Manufacturer method for addressing infiltration in areas where groundwater is present that is in accordance with the Owner requirements.

C. Shop Drawings:
   1. Submit manufacturer's data and details of following items for approval:
      a. Frame and covers.
      b. Grade rings.
      c. Manhole cones and risers.
      d. Manhole bases, if precast.
   2. Manhole construction details, jointing methods, connection details, materials, and dimensions.
   3. Repair procedures and details.
   4. Sealed drawings and design calculations by a registered Professional Engineer licensed in the state where the project is located.

D. Calculations and criteria used in manhole design including material properties, loadings, load combinations, and dimensions assumed.

1.04 PRODUCT REQUIREMENTS

A. As specified in Section 01_60_00 - Product Requirements.

B. Provide suitable quantities of lifting equipment to handle the manholes/risers and castings.
   1. In no case shall any equipment be used that is not rated to handle the intended loading or conditions of use to which it will be subjected, or which will damage or gouge the manhole components.
   2. Dragging or dropping the manhole components shall not be allowed.

C. Source Testing.
   1. Perform pre-production and post-production tests by manufacturer staff with a minimum of 5 years of experience in quality control, inspection, and testing of manholes.
      a. In lieu of this experience, witness of tests by up to 3 full-time Owner representatives.
   2. Provide the Manufacturer's Certificate of Source Testing.

1.05 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

B. Special warranty:
   1. Provide 50-year warranty stating that if the maximum wall thickness loss due to corrosion exceeds 0.75 inches, the Owner will not be responsible for manhole repair costs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manhole grade rings, cones, and risers:
   1. One of the following, or equal:
      a. Armorock.
      b. U.S. Composite Pipe.

B. Manhole frames and covers:
   1. One of the following, or equal:
      a. Alhambra Foundry Co.
      b. Neenah Foundry Co.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Manholes shall not include steps.

B. Manhole lids: Locking type.

C. Manhole bases:
   1. Constructed as part of the pipe installation or using tee risers.

D. Manhole riser:
   1. Made of the same pipe material selected for the project, providing a sealed connection between the pipe base and riser as indicated on the Drawings.
   2. Manufactured specifically for this project and no materials shall be furnished from stock unless approved by the Engineer.

E. Manhole provider shall coordinate with the pipe manufacturer for dimensions and connections.

F. Manhole systems:
   1. Provided by a single manufacturer.

G. Frames and covers:
   1. Provided by a single manufacturer unless approved by the Engineer.

2.03 BASIS OF DESIGN

A. Design in accordance with local jurisdiction requirements, including, but not limited to, the following:
   1. Manhole frames and covers.
   2. Manhole diameter tolerance.
   3. Manhole length.
   4. Manhole cover bolting.
   5. Manhole backfill.

B. Structural design calculations:
   1. Load rating of manhole:
      a. Design to support an AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading.
   2. Resist buoyancy:
      a. Design with sufficient bottom anchorage, base, and side friction to resist buoyancy.
      b. Depths will be as indicated on the Drawings.
      c. Refer to the geotechnical report for soil condition including fully saturated soil conditions.

C. Free from defects, including indentations, cracks, foreign inclusions, and resin starved areas that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part.

D. Maximum variation of internal diameter of manhole components: 1 percent.

E. Maximum variation in height of 2 opposite sides of risers and conical tops: 5/8 inch.

F. Maximum under run height of a riser or conical top: 1/4 inch per foot of height with a maximum of 1/2 inch in any one section.

G. Provide steel reinforcement in accordance with ASTM C478.

H. Manhole grade rings, risers, and bases:
   1. Manhole:
      a. Nominal sizes as indicated on the Drawings.
   2. Grade rings:
      a. At least 1 but not more than 2 grade rings shall be used.
      b. Maximum total distance from top of cone section to final grade: 18 inches.
   3. Cone and riser sections:
      a. As specified in this Section and as indicated on the Drawings.
   4. Manhole bases:
      a. As specified in this Section and as indicated on the Drawings.
      b. Provide corrosion protection system on unlined concrete.

I. Threaded lifting inserts:
   1. Design inserts to be fully threaded:
      a. Do not fully penetrate through entire manhole wall.
   2. Compatible with spreader bar and chains, hooks and slings.

3. Minimum safety factor of 4.0.
4. Do not use reinforcing steel bars.

2.04 IDENTIFICATION MARKINGS

A. Identification marks on the exterior of bases, risers, grade rings, and include the following information:
   1. Date of manufacture of the item.
   2. Name or trademark of the manufacturer.
   3. Internal diameter in inches.
   4. Number of the manhole as indicated on the Drawings.

2.05 QUALITY CONTROL

A. Manufacturer to provide permanent quality control department and laboratory facility capable of performing inspections and testing as specified by this Section.

B. Material testing, inspection procedures, and manufacturing process are subject to inspection by the Owner or Owner's representative.

C. Perform manufacturer's tests and inspections in accordance with the referenced standards and as specified in this Section, including the following:
   1. Provide the Manufacturer's Certificate of Source Testing as specified in Section 01_60_00 - Product Requirements.
   2. Manufacturer shall make available services of representative throughout the project duration when deemed necessary by the Engineer.
   3. Calibrate within last 12 months for equipment such as scales, measuring devices and calibration tools used in the manufacturing of pipe.
      a. Each device used in the manufacture of manholes is required to have a tag recording date of last calibration.
      b. Devices are subject to inspection by the Engineer.

D. Furnish labor necessary to assist the Engineer in inspecting manholes upon delivery.

E. Remove rejected manholes immediately.

2.06 MATERIALS

A. Cast iron manhole frames and covers:
   1. In accordance with ASTM A48.
   2. Provide bolted covers as specified and as indicated on the Drawings.
   3. Provide concrete collars as specified and as indicated on the Drawings.

B. Manhole risers, transition slabs, conical tops, grade rings, and manhole base sections in accordance with ASTM C478 and ASTM C857 as modified to accept polymer construction in lieu of concrete as follows:
   1. Polymer mixture:
      a. Ingredients: Consist solely of thermosetting resin, sand, and aggregate.
         1) No cementitious materials shall be allowed.
      b. Show required wall thickness for members in Shop Drawings.

c. Design to resist hydrostatic pressures with a minimum safety factor of 2.0 for full depth conditions from grade to riser connection point.
d. Minimum wall thickness:
1) 72-inch diameter manholes: 3-inches.
2) 48-inch and 60-inch diameter manholes: 2-inches.
e. Minimum unconfined compressive strength in accordance with ASTM C497: 9,000 pounds per square inch.

2. Provide riser sections joined with bell and spigot or ship-lap design seamed with butyl mastic or elastomeric gasket so that on assembly, manhole base, riser and top section make a continuous and uniform manhole.
3. Construct riser sections for polymer concrete manholes from standard polymer concrete manhole sections of the diameter as indicated on the Drawings.
4. Use various lengths of manhole sections in combination to provide correct height with the fewest joints.
5. Design wall sections in accordance with ASTM C478, design to support an AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading and manufacturer's recommendations.

C. Thermosetting resin:
1. Minimum of deflection temperature when tested at 264 pounds per square inch in accordance with Test Method ASTM D648: 158 degrees Fahrenheit.
2. Minimum resin content tested in accordance with test method ASTM D2584: 7 percent of the weight of the sample.
3. Material: Polyester or vinyl ester suitable for applications in the corrosive conditions to which the structures will be exposed.
4. Resin additives such as curing agents, pigments, dyes, fillers, and thixotropic agents, cannot be detrimental to the manhole.

D. Filler:
1. Materials:
a. Aggregate, sand, and quartz powder.
b. In accordance with ASTM C33, where applicable.

2.07 COMPONENTS

A. Manhole joints: Bell and spigot or ship-lap.

B. Joint sealing surfaces: Free of dents, gouges and other surface irregularities that would affect joint integrity.

C. Joint sealant:
1. Elastomeric gaskets suitable for the service intended.
2. Gaskets: In accordance with ASTM C443 and C990.

D. Vault access hatch:
    1. Where openings for access to the vault are required.
    2. Provide full clear space opening indicated on the Drawings without obstructions.
        a. Large openings:
            1) Brackets or supports are designed to protrude into the opening for support of required covers.
            2) Design brackets or supports to be easily removed and replaced with a minimum of effort and without cutting or welding.
        b. Vaults: Aluminum plate hinged floor access door (hatch) as specified:
            1) Load rating:
                a) “Heavy Duty” for covers.
            2) Minimum access door size not less than 36 inches square, unless otherwise indicated on the Drawings.
            3) Provide bearing surface with pre-installed continuous elastomeric gasket to minimize water infiltration at lid.
            4) Provide skid-resistant lid with cast-in or machined-in grid pattern.
            5) Manufacturers: One of the following, or equal:
                a) Babcock Davis Associates, Inc., Model BFDDH-SAL or BFDDH DAL (double leaf).
                b) The Bilco Co., Model JH-20 or JDH-20 (double leaf).
            6) Style: Double leaf.
            7) Material: Aluminum.
                a) Design to support an AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading with a maximum deflection of 1/150 of the span, live load channel frame, with drainage couplings.
            8) Door leaf: Minimum 1/4 inch, diamond-pattern plate reinforced with stiffeners as required to meet specified live load.
            9) Frame: 1/4-inch channel with anchor flange around perimeter.
            10) Hardware:
                a) Hinges: Each leaf equipped with a minimum of 2 heavy forged-brass hinges with stainless steel pins.
                b) Lock: Snap lock with removable handle mounted on door leaf.
                c) Grip handle: Provide vinyl grip handle designed to release cover for closing.
                d) Operating mechanism: Spring operators designed for ease of operation and automatic hold-open arm with release handle.
                e) Drainage assembly: Provide1-1/2-inch drainage coupling located in corner of the channel frame. Drain shall be routed outside of handhole.
        c. Set direction of double leaf hinged hatches in lid in coordination with Owner requirements.

E. Resilient pipe connectors:
   1. Unless otherwise indicated on the Drawings or specified, provide a flexible compression type connector between manhole and pipes entering and leaving the manhole in accordance with ASTM C923.
   2. Resilient pipe connectors:
      a. Manufacturers: The following or equal.
         1) A-LOK Premium.

F. Threaded lifting inserts.

2.08 IDENTIFICATION MARKINGS

A. Stenciled in minimum 1-inch letters, on the interior and exterior of precast bases, risers, grade rings.

B. Include the following information:
   1. Date of manufacturer of the item.
   2. Name or trademark of the manufacturer.
   3. Internal diameter in inches.
   4. Number of the manhole as indicated on the Drawings.

PART 3 EXECUTION

3.01 MANHOLE INSTALLATION

A. Engineer may inspect manhole sections prior to installation.

B. Manufacturer shall make available services of representative throughout the project duration when deemed necessary by the Engineer.

C. Excavation and backfill as specified in Section 31_23_35 - Trenching and as indicated on the Drawings.

D. Install manholes as indicated on the Drawings.

E. Maintain identifying markings (stamped or painted numberings, tags, etc.) on installed pieces throughout installation.

F. Manhole sections placement:
   1. Set manhole sections to be vertical, with sections in true alignment.
   2. Cover the joint of the previously set section with joint sealant or joint lubricant to elastomeric seals before the next section is placed.
   3. Remove excess joint sealant prior to installation of grout to cover the joint.

G. Construct invert channels, if applicable, to provide smooth flow transition waterway with no disruption of flow at pipe to manhole connections.
   1. Invert slope through manhole as indicated on the Drawings.
   2. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

3. Polymer bench and channel, if applicable, are to be constructed with resin aggregate material - no alternative fill material is allowed.
4. Do not use sections with chips or cracks in the joint.
5. Install butyl mastic or elastomeric gasket material in accordance with manufacturer's instructions.
6. Fill pick holes with grout.
7. Completed manhole shall be rigid and watertight.

H. Minimum clear distance between 2 wall penetrations:
1. Minimum of 6 inches on 48- to 72-inch diameter manholes.
2. Minimum of 8 inches on larger diameter manhole.

I. Minimum clear distance between wall penetration and joint.
1. Minimum of 3 inches.

J. Complete pavement prior to setting existing and new manhole frames and covers to final grade, unless otherwise approved by the Engineer.
1. Install reinforced concrete manhole collars as indicated on the Drawings.
2. Protect openings in manholes from construction loads, debris and unauthorized entry.

K. Restore area disturbed by manhole installation including slope protection, re-vegetation, and road restoration.

L. Repair of manhole sections damaged during installation in accordance with manufacturer's repair procedures and with the concurrence of the Engineer.

M. Install joint sealant material in accordance with manufacturer's instructions.
1. Completed manhole shall be rigid and watertight.

N. Lay grade rings in butyl mastic or plastic joint sealant with sides plumb and tops level.
1. Maximum total height of grade rings: Not to exceed the limits as indicated on the Drawings.

O. Set frame and covers in accordance with Owner requirements and as indicated on the Drawings.

3.02 CLEANING

A. After completing each manhole, remove debris, construction materials, and equipment from the site of the work, grade, and smooth over the surface and leave the entire right-of-way in a clean, neat, and serviceable condition.

B. After completing each manhole, remove construction material debris from inside the manhole.

3.03 FUNCTIONAL TESTING

A. Provide materials for grouting and patching recommended by the manufacturer or an approved equal.
   1. Polyester, vinyl ester, or epoxy resin mortar compound provided by the manufacturer.

B. Vacuum testing in accordance with ASTM C1244.
   1. Install the vacuum test head on top of the manhole.
      a. Install and brace sealing devices on influent and effluent pipes.
   2. Draw a vacuum of 10 inches of mercury with a vacuum pump, deactivate the pump, and measure the actual elapsed time for the vacuum to drop to 9 inches of mercury.

C. Compare test results with the minimum time requirements stated in the table below:

Minimum Time, Minutes: Seconds				
Manhole Depth, feet.	**Manhole Diameter, inches**			
	36	**48**	**60**	**72**
8	0:14	0:20	0:26	0:33
10	0:18	0:25	0:33	0:41
12	0:21	0:30	0:39	0:49
14	0:25	0:35	0:46	0:57
16	0:28	0:40	0:52	1:07
18	0:32	0:45	0:59	1:13
20	0:35	0:50	1:05	1:21
22	0:38	0:55	1:12	1:29
24	0:42	0:59	1:18	1:37
26	0:46	1:04	1:25	1:45
28	0:49	1:09	1:31	1:53
30	0:53	1:14	1:38	2:01

   1. If the time is less than the time in the table, the manhole is defective, and it shall be repaired and retested until it is acceptable.

END OF SECTION

SECTION 33_41_00

STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work includes but is not limited to following:
   1. Installation of new public storm sewer pipes, and storm drain catch basins as shown on the Plans.
   2. Stormwater collected.
   3. Drainage for retaining walls.

1.02 RELATED SECTIONS

A. Coordinate related work specified in other parts of the Project Manual, including but not limited to following:
   1. Section 31_23_35 - Trenching.
   2. Section 31_32_11 - Soil Surface Erosion Control.
   3. Section 31_00_00 - Earthwork.

1.03 REFERENCES

A. WSDOT Standard Specifications for Road, Bridge and Municipal Construction, 2025 edition.

1.04 SUBMITTALS

A. Submit in accordance with Section 01_33_00 - Submittal Procedures.
   1. Catch Basins and appurtenances.
   2. Storm drain piping and accessories with product installation literature.

1.05 QUALITY ASSURANCE

A. Manufacturer/Installer shall be a Specialist.

B. Regulatory Requirements - See Section 01_41_00 - Regulatory Requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Comply with “Quality Assurance” provisions, “References,” and Specifications. Where these may be in conflict, the more stringent requirements govern.

2.02 MATERIALS

A. Storm Sewer Pipe:
   1. Pipe used for storm sewers (corrugated exterior and smooth interior) polyethylene meeting the requirements of WSDOT Standard Specification 9-05.20 - Corrugated Polyethylene Storm Sewer Pipe.
   2. For storm pipes with less than 18 inches (1.5 feet) of cover, the material shall be ductile iron, which shall comply with WSDOT Standard Specifications 9-05.13 Ductile Iron Sewer Pipe.
   3. Detectable marking tape shall comply with Standard Specification 9-15.18. Tape widths to be per manufacture's recommendations based on pipe sizes.

B. Catch Basins
   1. Type 1 Catch Basins shall comply with WSDOT Standard Specification 9-05.50(3) - Precast Concrete Catch Basins, and WSDOT Standard Plan B-5.20-03.
   2. Type 2 Catch Basins shall comply with WSDOT Standard Specification 9-05.50(3) - Precast Concrete Catch Basins, and WSDOT Standard Plan B-10.20-02.
   3. Adjusting sections shall be precast concrete intended for the application.
   4. Metal frame and solid metal covers shall comply with WSDOT Standard Specification 9-05.15 - Metal Castings, and WSDOT Standard Plan B-30.10-03, B-30.70-04, and B-30.20-04. Bi-directional vaned grates shall comply with WSDOT Standard Specification 9-05.15-metal castings and WSDOT Standard Plans B-30.40-03 and B-30.40.03.

C. Bedding and Backfill. Bedding and backfill materials shall be per Section 31_23_35 - Trenching. Controlled Density Fill (CDF) shall be per WSDOT 2-09.3(1)E.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify installation conditions as satisfactory to receive work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 INSTALLATION

A. Install in accordance with "Quality Assurance" provisions, "References," Specifications, and Manufacturer's directions. Where these may be in conflict, the more stringent requirements govern.

B. Line and Grade.
   1. Survey line and grade shall be established prior to laying pipe per Standard Specification 7-08.3(2)A. Contractor to provide construction layout staking.
   2. In areas between survey stakes, transfer line and grade from the Plans to the storm line trench and maintain said line and grade using construction practices in conformance with established industry standards.

C. Handling, Storage and Cutting of Pipe.
   1. Material shall be stored in such a manner to prevent the pipe from bowing or otherwise being damaged.
   2. Saw cut pipe to leave a smooth end at right angles to the pipe axis. Prior to joining pipe, cut ends shall be de-burred, beveled and in accordance with the type of joint to be made.

D. Pipe Installation
   1. Storm sewer pipe shall be constructed in accordance with WSDOT Standard Specification 7-08 - General Pipe Installation Requirements.
   2. Pipe shall be installed on a well bedded, prepared foundation throughout its length per Section 31_23_35 - Trenching. Grade the bottom of the trench by hand, if necessary, to the line and grade to which the pipe is to be laid, with proper allowance for pipe thickness and for bedding material.
   3. The pipe shall be uniformly bedded under and around the entire length of the barrel. The bedding shall be dug out to accommodate pipe bells and prevent the joints from supporting excess weight.
   4. Take precautions to prevent water from entering the trench during excavation. Do not lay pipe when, in the opinion of the Owner, trench conditions are unsuitable.
   5. Prevent excavated or other foreign material from entering the pipe during the laying operation. When laying operations are not in progress, at the close of the day's work, or when labor is absent from the job, close and block all open pipe ends to prevent entry of foreign material or creep of the joints.
   6. Take all precautions necessary to prevent the "uplift" or floating of the line prior to the completion of the backfilling operation.
   7. In areas where pipe cover is less than one foot, controlled density fill (CDF) shall be used to encase pipe. The pipe shall have at least one foot of CDF below bottom of pipe and one foot of CDF on either side of pipe, measured from the outer wall of the pipe. CDF shall be used to cover the pipe, bringing it to grade in unpaved areas and up to the bottom of the crushed surfacing if below pavement.

E. Catch Basins.
   1. All catch basins shall be installed per WSDOT Standard Specification 7-05.3 including excavation, foundation preparation, installation, plumbing and finishing.
   2. Pipes entering catch basins shall be trimmed flush with the grouted fillet between the pipe and catch basin structure. Any damage to grouting during trimming operations shall be corrected to the satisfaction of the Owner.
   3. The iron frame and grate shall be set to the plan elevation by means of precast concrete grade rings, adjusting rings, or concrete bricks. Scrap lumber, rocks or other material shall not be used in setting the rim elevations. The bearing surface of the all grade rings, bricks, and casting frame shall rest on a full mortar bed to provide a water tight seal between the precast structure and the casting.
   4. Prior to final acceptance, remove all debris from catch basins.

F. Removal of Storm Drain Sections to be Abandoned.
   1. Existing storm drain to be abandoned shall be removed as needed where in conflict with proposed facilities. Contractor shall cap or fill existing piping to be

abandoned. Excavate and remove existing sections of storm drain and catch basins which conflict with proposed grades. Properly dispose of removal debris offsite. Coordinate drain removal work with new drainage construction to provide satisfactory drainage for onsite and upstream areas at all times. Backfill abandoned trenched with Structural Fill in accordance with Section 31_23_35 - Trenching.

2. Any remaining abandoned piping shall be plugged per WSDOT Standard Specifications 7-08.3(4).

G. Surface Drainage.

1. During construction, grade, drain, and maintain work site so as to prevent unnecessary construction delays due to ponding. Protect existing drainage structures and adjacent properties from sedimentation, sediment runoff, and damaging drainage velocities.
2. Provide proper coordination of site grading, landscaping, sidewalk construction, surface trench drain and catch basin rim adjustments to assure positive drainage of entire site with no ponding, and all surface stormwater is directed away from the building.

3.03 ADJUSTING, CLEANING, AND REPLACEMENT

A. Make any adjustments as required.

B. Clean: Leave installations clean; premises free from residue of work of this section.

END OF SECTION

SECTION 40_05_00.01

COMMON WORK RESULTS FOR GENERAL PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Basic materials and methods for metallic and plastic piping systems.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B1.1 - Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms).
   2. B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
   3. B18.2.2 - Nuts for General Applications: Machine Screw Nuts; and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
   4. PCC-1 - Pressure Boundary Bolted Flange Joint Assembly.

B. American Water Work Association (AWWA):
   1. C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   2. C110 - Ductile-Iron and Gray-Iron Fittings.
   3. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   4. C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   5. C151 - Ductile-Iron Pipe, Centrifugally Cast.

C. ASTM International (ASTM):
   1. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   2. A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   3. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
   4. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   5. B88 - Standard Specification for Seamless Copper Water Tube.
   6. D395 - Standard Test Methods for Rubber Property—Compression Set.
   7. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
   8. D573 - Standard Test Method for Rubber—Deterioration in an Air Oven.
   9. D1149 - Standard Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment.
   10. D1330 - Standard Specification for Rubber Sheet Gaskets.
   11. D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing and Fittings.
   12. F37 - Standard Test Methods for Sealability of Gasket Materials.

13. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
14. F594 - Standard Specification for Stainless Steel Nuts.
15. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements of Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

D. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. Buried pipes: Pipes that are buried in the soil with or without a concrete pipe encasement.
2. Exposed pipe: Pipes that are located above ground, or located inside a structure, supported by a structure, or cast into a concrete structure.
3. Pipes adjacent to a wet wall: Pipe centerline within 10 inches of the wet wall.
4. Underground pipes: Buried pipes - see 1. above.
5. Underwater pipes: Pipes below the top of walls in basins or tanks containing water.
6. Wet wall: A wall with water on at least one side.

PART 2 PRODUCTS

2.01 GENERAL

A. Pipes:
1. Provide new pipe.
2. Piping provided from manufacturers/distributors inventory is subject to the following condition:
a. Provide proof pipe manufactured more than 6 months prior to delivery was stored properly and the material and/or coating was not subjected to ultraviolet (UV) degradation.
3. Mark each piece of pipe in accordance with applicable standards.

B. Materials in contact with drinking water:
1. As specified in Section 01_41_00 - Regulatory Requirements.

C. Coatings and linings requirements shown in the Pipe Schedule, as modified in the individual pipe Technical Sections, and as specified in Section 09_96_01 - High-Performance Coatings.

2.02 LINK TYPE SEALS

A. Characteristics:
1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.

2. Links to form a continuous rubber belt around the pipe.
3. Provide a nylon polymer pressure plate with Type 316 stainless steel hardware. Isolate pressure plate from contact with wall sleeve.
4. Hardware to be Type 316 stainless steel.
    a. Provide anti-galling lubricant for threads.

B. One of the following or equal:
1. Link-Seal.
2. Pipe Linx.

2.03 FLANGE BOLTS AND NUTS

A. General:
1. Washer: Provide for each nut.
    a. Shall be of the same material as the nut.
2. Nuts: Heavy hex-head.
3. Cut and finish flange bolts to project:
    a. Face of the bolt shall exceed face of nut by 1/8-inch minimum.
    b. A maximum of 1/4 inch beyond outside face of nut after assembly.
4. Tap holes for cap screws or stud bolts when used.
5. Lubricant for stainless steel bolts and nuts:
    a. Chloride-free.
    b. Manufacturers: One of the following or equal:
        1) Huskey, FG-1800 Anti-Seize.
        2) Weicon, Anti-Seize High-Tech.

B. Ductile iron pipe:
1. On exposed pipes with pressures equal to or less than 150 pounds per square inch gauge (psig):
    a. Bolts: In accordance with ASTM A307, Grade B.
    b. Nuts: In accordance with ASTM A563, Grade A.
    c. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
2. On exposed pipes with pressures greater than 150 psig:
    a. Bolts: In accordance with ASTM A193, Grade B7.
    b. Nuts: In accordance with ASTM A194, Grade 2H.
    c. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
3. On underwater pipes and pipes adjacent to wet walls:
    a. Bolts: In accordance with ASTM A193, Grade B8M.
    b. Nuts: In accordance with ASTM A194, Grade 8M.

C. Plastic pipe:
1. On exposed pipes:
    a. Bolts: In accordance with ASTM A307, Grade B.
    b. Nuts: In accordance with ASTM A563, Grade A.
    c. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
2. On underwater pipes and pipes adjacent to wet walls:
    a. Bolts: In accordance with ASTM A193, Grade B8M.
    b. Nuts: In accordance with ASTM A194, Grade 8M.

D. Steel pipe:
    1. Exposed flange bolts, nuts, and washers:
        a. Bolts: ASTM A193, Grade B7 Steel, ASME B1.1 Class 2A Threads, with dimensions in accordance with ASME B18.2.1.
        b. Nuts: ASTM A194, Grade 2H Steel, ASME B1.1 Class 2A Fit, with square or heavy hex dimensions in accordance with ASME B18.2.2.
        c. Washers: In accordance with ASME PCC-1, Appendix M, Type 4.
        d. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
    2. On underwater pipes and pipes adjacent to wet walls:
        a. Bolts: ASTM A193, Grade B8M Stainless Steel, ASME B1.1 Class 2A Threads, with dimensions in accordance with ASME B18.2.1.
        b. Nuts: ASTM A194, Grade 8M Stainless Steel, ASME B1.1 Class 2A Fit, with square or heavy hex dimensions in accordance with ASME B18.2.2.
        c. Washers: In accordance with ASME PCC-1, Appendix M, Type 7.

2.04 MECHANICAL JOINTS BOLTS AND NUTS

A. Bolts, including T-bolts:
    1. High strength low alloy steel in accordance with AWWA C111.
        a. Fluoropolymer coated.

B. Heavy hex nuts:
    1. High strength low alloy steel in accordance with AWWA C111.
        a. Fluoropolymer coated.

2.05 GASKETS

A. General.
    1. Suitable for the specific fluids, pressure, and temperature conditions.
    2. Capable of being applied on surface of piping with cavities to provide for an improved seal with the internal piping pressure.

B. For flanged joints in ductile iron and steel piping for sewage service:
    1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to and less than 250 degrees Fahrenheit, and raw sewage service.
    2. Material:
        a. SBR or neoprene elastomer with minimum Shore A hardness value of 70.
        b. Reinforcement: Cloth or synthetic fiber.
        c. Thickness: Minimum 3/32-inch thick for less than 10-inch pipe; minimum 1/8-inch thick for 10 inch and larger pipe.
    3. Manufacturers: One of the following or equal:
        a. Pipe less than 48 inches in diameter:
            1) Garlock, Style 7797.
            2) John Crane, similar product.
        b. Pipe 48 inches in diameter and larger:
            1) Garlock, Style 3760.
            2) John Crane, similar product.

C. For flanged joints in polyvinyl chloride and polyethylene piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, with low flange bolt loadings, temperatures equal to and less than 120 degrees Fahrenheit, and polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine, including fluorochemicals and gaseous fluorine.
   2. Material:
      a. Chemical systems: 0.125-inch thick Viton™ rubber.
      b. Sewer and water: 0.125-inch thick SBR.
   3. Manufacturers: One of the following or equal:
      a. Garlock.
      b. John Crane, similar product.

D. For flanged joints in low pressure air piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to and less than 300 degrees Fahrenheit, and compressed air service.
   2. Material:
      a. EPDM elastomer, 1/8-inch thick, 60 Shore hardness, smooth surface.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Style 8314.
      b. John Crane, similar product.

E. For flanged joints in ductile iron or steel water piping:
   1. Suitable for hot or cold water, pressures equal to and less than 150 pounds per square inch gauge, and temperatures equal to and less than 160 degrees Fahrenheit.
   2. Material:
      a. SBR or neoprene elastomer, compressed, with non-asbestos fiber reinforcement.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Bluegard 3300.
      b. John Crane, similar product.

F. For flanged joints in steel drinking water piping in accordance with NSF 61 requirements:
   1. Material: EPDM elastomer, Sulphur cure.
      a. Temperature range: -40 to 275 degrees Fahrenheit.
      b. Operating pressure: 150 psig.
      c. Durometer, Shore A (within 5): 80.
      d. ASTM D412 tensile strength: 1,500 psi.
      e. ASTM D412 elongation: 185 percent.
      f. ASTM D395 B, compression set, 25 percent deflection, maximum percentage 22 hours at 158 degrees Fahrenheit: 25.
   2. Thickness, minimum:
      a. 3/32-inch for less than 10-inch pipe.
      b. 1/8 inch for 10 inch and larger pipe.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Style 98206.
      b. John Crane.

G. For flanged joints in ductile iron drinking water piping in accordance with NSF 61 requirements:
   1. Application: Full faced type with one or more annular rings molded into the gasket as described in AWWA C110, C111, and C115.
   2. Material: Styrene butadiene copolymer (SBR).
      a. Temperature range: 20 to 150 degrees Fahrenheit.
      b. Operating pressure:
         1) Pipe size 4-inch through 24-inch: 350 psi.
         2) Pipe size 24 inch and greater: 250 psi.
   3. Thickness, minimum: 1/8 inch.
   4. Manufacturers: One of the following or equal:
      a. American Cast Iron Pipe Co., Toruseal Flange Gasket.
      b. U.S. Pipe, Flange-Tyte II.

H. For flanged joints in ductile iron drinking water piping in accordance with NSF 61 requirements:
   1. In accordance with AWWA C110, C111, and C115.
   2. Material: Styrene butadiene copolymer (SBR) in accordance with ASTM D1330 Grade II.
      a. Temperature range: 20 to 150 degrees Fahrenheit.
      b. Operating pressure: 250 psi.
      c. Durometer, Shore A: 70 to 85.
      d. ASTM D412 tensile strength: 700 psi.
      e. ASTM D412 elongation: 150 percent.
      f. ASTM D395 B, compression set, 25 percent deflection, maximum percentage 22 hours at 158 degrees Fahrenheit: 40.
   3. Thickness, minimum: 1/8 inch.
   4. Manufacturers: One of the following or equal:
      a. McWane Ductile.
      b. SIP industries.

I. For mechanical joints or wedge action joint restraints in ductile iron drinking water piping in accordance with NSF 61 requirements:
   1. In accordance with AWWA C110, C111, and C115.
   2. Material: Vulcanized styrene butadiene copolymer (SBR).
      a. Temperature range: 20 to 150 degrees Fahrenheit.
      b. Operating pressure: 250 psi.
      c. Durometer, Shore A (within 5): 75.
      d. ASTM D412 tensile strength: 1,500 psi.
      e. ASTM D412 elongation: 150 percent.
      f. ASTM D395 B, compression set, 25 percent deflection, maximum percentage 22 hours at 158 degrees Fahrenheit: 20.
      g. ASTM D573 minimum aging: 60 percent.
      h. ASTM D1149 resistance to surface ozone: No cracking.
   3. Manufacturers: One of the following or equal:
      a. American Cast Iron Pipe Co.
      b. EBAA Iron, Inc.
      c. Star Pipe Products.

J. For push-on joints in ductile iron drinking water piping in accordance with NSF 61 requirements:
   1. In accordance with AWWA C110, C111, and C115.
   2. Material: Vulcanized styrene butadiene copolymer (SBR).
      a. Temperature range: 20 to 150 degrees Fahrenheit.
      b. Operating pressure: 250 psi.
      c. Durometer, Shore A:
         1) Main body: 50 to 65.
         2) Harder portion (if used): 80 to 85.
      d. ASTM D412 tensile strength:
         1) Main body: 2,000 psi.
         2) Harder portion (if used): 1,200 psi.
      e. ASTM D412 elongation:
         1) Main body: 300 percent.
         2) Harder portion (if used): 125 percent.
      f. ASTM D395 B, compression set, 25 percent deflection, maximum percentage 22 hours at 158 degrees Fahrenheit: 20.
      g. ASTM D573 minimum aging: 60 percent.
      h. ASTM D1149 resistance to surface ozone: No cracking.
   3. Manufacturers: One of the following or equal:
      a. American Cast Iron Pipe Co, Fastite Gasket.
      b. McWane Ductile, Tyton Gasket.
      c. U.S. Pipe.

K. For integrally restrained push-on joints in ductile iron drinking water piping in accordance with NSF 61 requirements:
   1. In accordance with AWWA C110, C111, and C115.
   2. Material: Vulcanized styrene butadiene copolymer (SBR).
      a. Temperature range: 20 to 150 degrees Fahrenheit.
      b. Operating pressure: 250 psi.
      c. Durometer, Shore A:
         1) Main body: 50 to 65.
         2) Harder portion (if used): 80 to 85.
      d. ASTM D412 tensile strength:
         1) Main body: 2,000 psi.
         2) Harder portion (if used): 1,200 psi.
      e. ASTM D412 elongation:
         1) Main body: 300 percent.
         2) Harder portion (if used): 125 percent.
      f. ASTM D395 B, compression set, 25 percent deflection, maximum percentage 22 hours at 158 degrees Fahrenheit: 20.
      g. ASTM D573 minimum aging: 60 percent.
      h. ASTM D1149 resistance to surface ozone: No cracking.
   3. Manufacturers: One of the following or equal:
      a. American Cast Iron Pipe Co, Fast-grip gasket.
      b. U.S. Pipe, Field Lok 350 Gaskets.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Piping drawings:
      a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
      b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
         1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.
   2. Piping alternatives:
      a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
      b. Alternative pipe ratings:
         1) Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price.
         2) Piping of different material may not be substituted in lieu of specified piping.
      c. Valves in piping sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
      d. Grooved joints: Use couplings, flange adapters, and fittings of the same manufacturer.
         1) Manufacturer's factory trained representative:
            a) Provide on-site training for the Contractor's field personnel.
            b) Periodically visit the jobsite to verify the Contractor is following best recommended practices.
         2) Distributor's representative is not considered qualified to conduct the training or jobsite visits.
      e. Flanged joints: Where one of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.
   3. Unless otherwise indicated on the Drawings, piping at pipe joints, fittings, couplings, and equipment shall be installed without rotation, angular deflection, vertical offset, or horizontal offset.

B. Wall and slab penetrations:
   1. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.
   2. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.
      a. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
      b. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.

c. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
d. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.

3. Provide flexibility in piping connecting to structures to accommodate movement due to soil settlement and earthquakes. Provide flexibility using details indicated on the Drawings.
4. Core drilled openings:
   a. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by the Engineer.
   b. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device.
   c. Remove dust and debris from hole using compressed air.

C. Exposed piping:
1. Install in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings.
   a. Install piping runs plumb and level, unless otherwise indicated on the Drawings.
      1) Slope plumbing drain piping with a minimum of 1/4 inch per foot downward in the direction of flow.
2. Install after installing equipment and after piping and fitting locations have been determined.
3. Route piping to preserve headroom, access space and workspace, and to prevent tripping hazards and clearance problems:
   a. Install piping so it does not interfere with the proper and safe operation of equipment and does not block or interfere with ingress or egress, including hatches.
4. Support piping: As specified in Section 40_05_07.01 - Pipe Supports, and Section 40_05_07.03 - Preformed Channel Pipe Support System:
   a. Do not transfer pipe loads and strain to equipment.
5. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
6. Assemble piping without distortion or stresses caused by misalignment:
   a. Match and properly orient flanges, unions, flexible couplings, and other connections.
   b. Do not subject piping to bending or other undue stresses when fitting piping.
   c. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
   d. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
   e. Alter piping assembly to fit when proper fit is not obtained.
   f. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

D. Buried piping:
   1. Bury piping with minimum 3-foot cover without air traps, unless otherwise indicated on the Drawings.
   2. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench.
      a. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
   3. Laying piping:
      a. In finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
      b. Place piping with top or bottom markings with markings in proper position.
      c. On an unyielding foundation with uniform bearing under the full length of barrels.
      d. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
      e. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.
   4. Concrete encase buried pipe installed under concrete slabs or structures.

E. Venting piping under pressure:
   1. Lay piping under pressure flat or at a continuous slope without air traps, unless otherwise indicated on the Drawings.
   2. Install plug valves as air bleeder cocks at high points in piping.
      a. Provide 1-inch plug valves for water lines and 2-inch plug valves for sewage and sludge lines, unless otherwise indicated on the Drawings.
   3. Provide additional pipe taps with plug cocks and riser pipes along piping as required for venting during initial filling, disinfecting, and sampling.
   4. Before piping is placed into service, close plug valves and install plugs. Protect plugs and plug valves from corrosion as specified in Section 09_96_01 - High-Performance Coatings.

F. Restraining buried piping:
   1. At valves and at fittings where piping changes direction, changes size, and at ends:
      a. When piping is underground, use concrete thrust blocks, mechanical restraints, or push-on restraints.
      b. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by design test pressure of the piping.
   2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
      a. During testing, provide suitable temporary restraints where piping does not require permanent restraints.
   3. Place concrete thrust blocks against undisturbed soil.
   4. Place concrete so piping joints, fittings, and other appurtenances are accessible for assembly and disassembly.
   5. Provide underground mechanical restraints where specified in Attachment A - Pipe Schedule.

G. Restraining above ground piping:
    1. At valves and fittings where piping changes direction, changes size, and at ends:
        a. When piping is aboveground or underwater, use mechanical or structural restraints.
        b. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by design test pressure of the piping.
    2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
        c. During testing, provide suitable temporary restraints where piping does not require permanent restraints.

H. Connections to existing piping:
    1. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
        a. Protect domestic water/potable water supplies from contamination:
            1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
            2) Provide devices approved by the owner of the domestic water supply system to prevent flow from other sources into the domestic supply system.
    2. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
    3. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
    4. For flanged connections, provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

I. Connections between ferrous and nonferrous metals:
    1. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings, especially designed for the prevention of chemical reactions between dissimilar metals.
    2. Nonferrous metals include aluminum, copper, and copper alloys.

J. Flanged connections between dissimilar metals such as ductile iron pipe and steel pipe:
    1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.02 CLEANING

A. Piping cleaning:
    1. Upon completion of installation, clean piping interior of foreign matter and debris.
    2. Perform special cleaning when required by the Contract Documents.

B. Air piping:
    1. Perform special cleaning of filtered air piping from the intake clean air plenums to the discharge points and high-pressure air piping.
        a. Protect surfaces from contamination.

2. Special cleaning shall include wire brushing, power tool cleaning, wiping down with lint-free cloths, brooming, and vacuuming to remove rust, scale, weld spatter, dust, dirt, oil, and other matter deleterious to operation of the air system:
    a. Do not sandblast installed piping.
3. To the greatest extent possible, clean piping immediately prior to final closure of piping systems:
    a. Enter piping, clean and wipe down surfaces, and vacuum out residue.
    b. Clean surfaces not accessible to this cleaning operation after installation within 6 hours preceding installation.
4. Subsequent to cleaning, protect surfaces from contamination by dust, dirt, construction debris, and moisture, including atmospheric moisture:
    a. Whether or not pipe upstream has been cleaned, temporarily seal openings in partially completed work except when installation is actively in progress.
    b. When installation is actively in progress, seal openings at the end of each day's construction or when construction is temporarily stopped.
5. Suspend cleaning and seal openings when inclement weather, including dust storms, is imminent.
6. Use clean, dry air for testing the piping and other elements of the system.
7. Prior to introduction of air to the system, blow piping clean.
    a. Blow with maximum discharge rate possible for minimum 4 hours, using new blowers or compressors and filters.
8. Clean surfaces that become contaminated prior to acceptance.

C. Conduct pressure and leak test, as specified.

3.03 PIPE SCHEDULE

A. As specified in Attachment A - Pipe Schedule.

END OF SECTION

ATTACHMENT A - PIPE SCHEDULE

PIPE SCHEDULE

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Service Conditions	Comments
AI	Air, Instrument										
		Less than 2	316 SST	SCH 10	40_05_23.01 - Stainless Steel Pipe and Tubing	Press Fit	200 psig/ HH	None	None		
		2 and more	316 SST	SCH 10	40_05_23.01 - Stainless Steel Pipe and Tubing	WLD, FL, or SCRD	200 psig/ HH	None	None		
AS	Air, Service										
	Exposed	Less than 2	316 SST	SCH 10	40_05_23.01 - Stainless Steel Pipe and Tubing	Press Fit	200 psig/ HH	None	None		
BS	Blended Sludge										
	Underground	3 and less	PVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	150 psig/HH	None	None		
		4 – 12	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	RPO or Rest. MJ	150 psig/HH	GL	2 Layers PEE		
	Aboveground	3 and less	304 SST	SCH 10	40_05_23.01 - Stainless Steel Pipe and Tubing	SCRD, WLD, GE, Press, FL	150 psig/HH	None	None		
		4 – 12	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	GE, FL where indicated	150 psig/HH	GL	EPU-M-1		Insulate and heat trace in Area 440
		4 – 12	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	GE, FL where indicated	150 psig/HH	GL	EPX-M-2		In contact with sludge storage tank interior

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Service Conditions	Comments
D	Drain										
	Underground 1	12 or less	CISP		22_42_01 - Plumbing Systems	B&SP	15 feet/GR	CTP	CTP		Within 5’ of building
		14 or more	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	RPO or Rest. MJ	15 ft/GR	GL	2 Layers PEE		
	Underground 2	8 or less	PVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	15 ft/GR	None	None		Outside 5’ of building
		10 - 12	PVC	C900	40_05_31.01 - Plastic Piping and Tubing	PO or MJ	15 ft/GR	None	None		
	Underground 3	8 or less	CPVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	15 ft/GR	None	None		Odor control drain
AI	Instrument Air										
		Less than 2	316 SST	SCH 10	40_05_23.01 - Stainless Steel Pipe and Tubing	Press Fit	200 psig/ HH	None	None		
		2 and more	316 SST	SCH 10	40_05_23.01 - Stainless Steel Pipe and Tubing	WLD, FL, or SCRD	200 psig/ HH	None	None		
PD	Process Drainage										
	Underground 1	3 and less	PVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	125 psig/ HH	None	None		
		4 or more	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	RPO or Rest. MJ	125 psig/HH	CM	2 layers PEE		

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Service Conditions	Comments
	Underground 2	8 or less	CPVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	15 ft/GR	None	None		From polymer concrete manhole to raw sewage pump station
	Aboveground	3 and less	PVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	125 psig/ HH	None	EPU-M-1		
		4 - 12	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	GE, FL where indicated	125 psig/ HH	CM	EPU-M-1		
RAS	Return Activated Sludge										
	Exposed	3 and more	STL	As specified	40_05_24.01 – Steel Pipe: Exposed	GE, FL where indicated	50 psig/HH	PCP	EPU-M-1		
RS	Raw Sewage										
	Underground	3 and less	PVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	125 psig/ HH	None	None		
		4 or more	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	RPO or Rest. MJ	125 psig/HH	CM	2 layers PEE		
	Underground, Gravity	6	PVC	Class Type; SDR 26	40_05_31.01 - Plastic Piping and Tubing	RPO	15 feet/GR	None	None		Manhole to Raw Sewage Pump Station

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Service Conditions	Comments
	Aboveground	3 and less	PVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	125 psig/ HH	None	EPU-M-1		
		4 - 12	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	GE, FL where indicated	125 psig/ HH	CM	EPU-M-1		
SD	Storm Drain										
	Underground 1	12 or less	CISP		22_42_01 - Plumbing Systems	B&SP	15 feet/GR	CTP	CTP		Within 5’ of building
		14 or more	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	RPO or Rest. MJ	15 ft/GR	CM	2 Layers PEE		
	Underground 2	18 or less	Corrugated Polyethylene		33_41_00 - Storm Utility Drainage Piping	B&SP	15 ft/GR	None	None		Outside 5’ of building
WAS	Waste Activated Sludge										
	Exposed	3 and more	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	GE, FL where indicated	50 psig/HH	Ceramic Epoxy	EPU-M-1		
W1	Potable Water										
	Underground	3 and less	Copper		40_05_17.05 - Copper Water Tube: Seamless, ASTM B88	Soldered	150 psig/HH	None	None		
		4 or more	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	Mech Rest. or RPO	150 psig/HH	CM	2 Layers PEE		

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Service Conditions	Comments
	Aboveground	< 3	Copper		40_05_17.05 – Copper Water Tube: Seamless, ASTM B88	Soldered	150 psig/HH	None	None		Insulate and heat trace in Area 440
		3 and more	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	FL or GE	150 psig/HH	CM	EPU-M-1		Insulate and heat trace in Area 440
W2	Non-Potable Water										
	Underground	3 and less	PVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	150 psig/ HH	None	None		
		4 - 12	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	FL	150 psig/ HH	CM	2 Layers PEE		
	Aboveground	3 and less	GSP	SCH 40	40_05_24.02 – Steel Pipe: ASTM A53	SCRD, GE, FL	150 psig/HH	Epoxy	EPX-M-2	Pump Seal water	Insulate and heat trace in Area 440
		4 - 12	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	FL	150 psig/ HH	CM	EPU-M-1		Insulate and heat trace in Area 440
W3	Plant Water										
	Underground	3 and less	PVC	SCH 80	40_05_31.01 - Plastic Piping and Tubing	SW	150 psig/ HH	None	None		
		4 - 12	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	FL	150 psig/ HH	CM	2 Layers PEE		

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Service Conditions	Comments
	Aboveground	3 and less	GSP	SCH 40	40_05_24.02 – Steel Pipe: ASTM A53	SCRD, GE, FL	150 psig/HH	Epoxy	EPX-M-2		Insulate and heat trace in Area 440
		4 - 12	DIP	CL 53	40_05_19.01 - Ductile Iron Pipe: AWWA C151	FL	150 psig/ HH	CM	EPX-M-2		Insulate and heat trace in Area 440

Abbreviations:

1. The following abbreviations used in the column of test method refer to the respective methods as specified in Section 40_05_00.09 - Piping Systems Testing.
   - AM Air method
   - GR Gravity method
   - HH High head method
   - LH Low head method
   - SC Special case
2. Abbreviations to designate piping include the following:
   - B&SP Bell and spigot
   - BSP Black Steel Pipe
   - CE Ceramic epoxy lining
   - CI Cast iron
   - CISP Cast iron soil pipe
   - CL Class, followed by the designation
   - CM Cement mortar
   - CTP Coal tar pitch
   - DIP Ductile iron piping
   - EPP Epoxy polyurethane coating
   - FL Flange
   - GA Gauge, preceded by the designation
   - GE Grooved end joint
   - GL Glass lined
   - GSP Galvanized steel pipe
   - MJ Mechanical joint
   - MWA Mechanical wedge action
   - NPS Nominal pipe size, followed by the number in inches
   - psi pounds per square inch
   - psig pounds per square inch gauge
   - PE Polyethylene
   - PEE Polyethylene encasement
   - PCP Plural Component Polyurethane per Section 40_05_24.01
   - PTW Polyethylene tape wrap
   - PVC Polyvinyl Chloride
   - RPO Restrained push-on
   - SCH Schedule, followed by the designation
   - SCRD Screwed-on
   - SST Stainless steel
   - SW Solvent welded
   - VCP Vitrified clay piping
   - WLD Weld

SECTION 40_05_00.03

PIPE IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pipe identification including the following:
   1. Pipe identification markers, flow direction arrows, tags, and bands.
   2. Underground warning tape.
   3. Tracer wire.
   4. Witness markers.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Submit following:
   1. Product data.
   2. Samples.
   3. Manufacturer's installation instructions.
   4. Submit following as specified in Section 01_77_00 - Closeout Procedures:
      a. Operation and Maintenance Data.
      b. Warranty.

PART 2 PRODUCTS

2.01 EXPOSED AND IN-CHASE PIPE IDENTIFICATION

A. For piping with outer diameter greater than or equal to 3/4-inch, provide lettered pipe markers and flow direction arrows:
   1. General requirements:
      a. Pipe markers shall include the following, minimum:
         1) Printed text identifying the pipe fluid.
            a) The text shall be all capital letters matching the text listed in the "Service" column of the Piping Schedule for the corresponding piping system.
         2) An arrow identifying the direction of fluid flow.
            a) The arrow can either be integral to the text marker or provided separately. If provided separately, the arrow must be placed immediately adjacent to each text marker, with the arrow aligned

with the text such that the text and arrow are both visible from the same viewpoint.

b) The arrow color shall match the text color, and the arrow background color shall match the text background color.

b. Suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

c. Lettering:

Outside Pipe Diameter Including Covering	Lettering Height
Less than 0.75 inches	N/A
0.75 to 1.5 inches	1/2-inch
1.5 inches to 2 inches	3/4-inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

d. Marker colors:

Marker Color System ID(1)	Fluid service	Text/Arrow Color	Background Color
1	Flammable and oxidizing fluids	Black	Yellow
2	Potable, cooling, boiler feed, and other waters	White	Green
3	Compressed air	White	Blue
4	Fire quenching fluids	White	Red
5	Toxic and corrosive fluids	Black	Orange
6	Combustible fluids	White	Brown
7	(Not used)	White	Purple
8	(Not used)	Black	White
9	Drain, Pumped Drainage	White	Gray
10	Blended, Primary, and Waste Activated Sludge	White	Black

Notes:
(1) See Piping Schedule.

2. Self-adhesive type markers:
   a. Manufacturers: One of the following or equal:
      1) Seton, (of Brady Corporation), Opti Code Pipe Markers.
      2) Marking Services, Inc.
   b. Materials:
      1) Self-adhesive vinyl.
3. Snap-on markers:
   a. Manufacturers: One of following or equal:
      1) Brady Snap-On.
      2) Seton (of Brady Corporation) Setmark.

B. For piping with outer diameter less than 3/4-inch, provide identification tags and flow direction arrows:
   1. Manufacturer: One of the following or equal:
      a. Seton (of Brady Corporation).
   2. Tag and chain materials:
      a. Copper piping: Brass.
      b. Ferrous piping: Type 316 stainless steel.
      c. Plastic piping: Stainless steel.
   3. Flow direction arrow colors shall adhere to the same requirements as for piping with outer diameter greater than or equal to 3/4 -inch, as specified in this Section.

C. Pipe bands:
   1. When bands are required by the Piping Schedule for a specific piping system, provide solid-colored 4-inch wide bands.
      a. Color as specified in the Piping Schedule.
   2. Self-adhesive type.
   3. Suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit.

2.02 BURIED PIPELINE IDENTIFICATION

A. Underground warning tape:
   1. Manufacturer: One of the following or equal:
      a. Seton (of Brady Corporation).
      b. T. Christy Enterprises, Inc.
   2. Material:
      a. Polyethylene tape for prolonged underground use.
      b. Minimum tape thickness: 4 mils.
      c. Overall tape width: 4 inches.
      d. Message: “CAUTION” with the name of the service followed by “LINE BURIED BELOW.” in black lettering on colored background in accordance with approved APWA colors.

Service	**Color**
Potable water	Blue
Reclaimed water, irrigation, and slurry lines	Purple
Sewers and drain lines	Green
Gas, oil, steam, petroleum, chemicals, or other service	Yellow

B. Tracer wire:
   1. Manufacturers: One of the following or equal:
      a. Kris-Tech Wire.
      b. Aegion Corrpro.
   2. Materials: One of the following or equal:
      a. Solid copper conductor
      b. Thickness minimum: 10 gauge.
      c. Insulation:
         1) Match insulation color to the color of the pipe being installed.
         2) UF type, direct bury.
         3) 30 mil HMWPE.

3. Splicing kit:
    a. Manufacturers: One of the following or equal:
        1) 3M, Model 82 A1N.
4. Station box:
    a. Lid and collar materials: Cast iron.
    b. Lid type: Locking.
    c. Able to withstand heavy traffic loading.
    d. Manufacturers: One of the following or equal:
        1) CP Test & Valve Products, Inc., Glenn Test Station.
        2) Farwest Corrosion Control.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified in Section 01_60_00 - Product Requirements.

3.02 PREPARATION

A. Prepare and coat piping with the coating systems defined in the Piping Schedule.

B. Prepare surface in accordance with identification product manufacturer's instructions.

3.03 EXPOSED AND IN-CHASE PIPING IDENTIFICATION

A. Identify exposed and in-chase piping with flow direction arrows and lettering (for piping with outer diameter greater than or equal to 3/4-inch) or tags (for piping with outer diameter less than 3/4-inch).

B. Provide lettering (or tags for pipes with outer diameter less than 3/4-inch) and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 50 feet in straight runs of pipe.
    1. Label all chemical tank fill pipelines at locations that are visible from chemical fill stations.
    2. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.
    3. Do not apply markers, arrows, or tags to piping that is regularly submerged.

C. Where scheduled in the Piping Schedule, space solid-color bands along piping at 10-foot intervals.
    1. Do not apply bands to piping that is regularly submerged.

3.04 BURIED PIPING IDENTIFICATION

A. Underground warning tape:
   1. Non-detectable warning tape:
      a. Place continuous run of warning tape in pipe trench, 12 inches above the pipe.

B. Tracer wire:
   1. Install on all non-metallic pipe.
   2. Install an electrically continuous run of tracer wire along the entire length of the pipe with wire terminations in valve boxes, vaults, or structures.
   3. Install tracer wire on top of the pipe and secure to pipe with tape a minimum of every 10 feet.
   4. Where approved by the Engineer, splice sections of wire together using approved direct bury wire nuts.
      a. Twisting the wires together is not acceptable.

END OF SECTION

SECTION 40_05_00.09

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Test requirements for piping systems.

1.02 REFERENCES

A. National Fuel Gas Code (NFGC).

B. American Society of Mechanical Engineers (ASME):
   1. B31.1 - Power Piping.
   2. B31.3 - Process Piping.
   3. B31.8 - Gas Transmission and Distribution Piping Systems.

C. Underwriters Laboratories Inc. (UL).

1.03 TESTING REQUIREMENTS

A. General requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 40_05_00.01 - Common Work Results for General Piping; are specified in the specifications covering the various types of piping; and are specified in this Section.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the plumbing code, as specified in Section 01_41_00 - Regulatory Requirements, and UL requirements.
   4. Test natural gas or digester gas piping:
      a. For less than 125 pounds per square inch gauge working pressure, test in accordance with mechanical code, as specified in Section 01_41_00 - Regulatory Requirements, or the National Fuel Gas Code, whichever is more stringent.
      b. For 125 pounds per square inch gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.
   5. When testing with water, the specified test pressure is considered to be the pressure at the lowest point of the piping section under test.
      a. Lower test pressure as necessary (based on elevation) if testing is performed at higher point of the pipe section.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for testing, cleaning, and disinfecting:
   1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01_50_00 - Temporary Facilities and Controls.

D. Pipes to be tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test completion: Drain and leave piping clean after successful testing.

G. Test water disposal: Dispose of testing water at location designated by Owner in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site. All requirements and costs associated with notifications and obtaining any discharge permit or approvals shall be responsibility of Contractor.

1.04 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Schedule and notification of tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of readiness to test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping.
   3. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

D. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TESTING ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and grade:
   1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
   2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection test:
   1. Pull a mandrel through the clean piping section under test.
   2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
   3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within 1 percent plus or minus.
   4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.02 AIR TESTING METHOD FOR PRESSURE PIPING

A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.

B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
   1. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 40_05_00.01 - Common Work Results for General Piping:
   1. Provide temporary pressure relief valve for piping under test:
      a. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
   2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ASME B31.1, ASME B31.3, ASME B31.8, or the pipe manufacturer's stated maximum working pressure.
   3. Gradually increase test pressure to an initial test pressure equal to the lesser of 1/2 the test pressure or 25 pounds per square inch gauge.

4. Perform initial check of joints and fittings for leakage.
5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage; at each step increase until test pressure reached.
6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.03 TESTING GRAVITY FLOW PIPING

A. Test gravity flow piping indicated with "GR" in the Piping Schedule, as follows:
   1. Unless specified otherwise, subject gravity flow piping to the following tests:
      a. Alignment and grade.
      b. For plastic piping test for deflection.
      c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
   2. Inspect piping for visible leaks before backfilling.
   3. Provide temporary restraints when needed to prevent movement of piping.
   4. Pressure test piping with maximum leakage allowance after backfilling.
   5. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours:
      a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
      b. Maintain piping with water, or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
      c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of 4 hours while accurately measuring the volume of water added to maintain the test pressure:
         1) Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:
            a) For concrete piping with rubber gasket joints: 80 gallons per day per inch of diameter per mile of piping under test:
               (1) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
            b) For vitrified clay piping: 500 gallons per day per inch of diameter per mile of piping under test.
            c) For other piping: 80 gallons per day per inch diameter per mile of piping under test.

3.04 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping Schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment, or piping specialties in test sections if test pressure exceeds the valve, equipment, or piping specialty safe test pressure allowed by the item's manufacturer.
   4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
   5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
   6. When test results indicate failure of selected sections, limit tests to piping:
      a. Between valves.
      b. Between a valve and the end of the piping.
      c. Less than 500 feet long.
   7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing procedures:
   1. Fill piping section under test slowly with water while venting air:
      a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
   3. Raise pressure to the specified test pressure and inspect piping visually for leaks:
      a. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
   1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
   2. Pressure test piping after completion of visible leaks test.
   3. For piping systems using joint designs other than flanged, threaded, or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
      b. Successful completion of the pressure test with maximum leakage allowance shall be achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

c. When leakage is allowed, calculate the allowable leakage by the following formula:

$L = S \times D \times P^{1/2} \times 148{,}000^{-1}$

wherein the terms shall mean:

L = Allowable leakage in gallons per hour.

S = Length of the test section in feet.

D = Nominal diameter of the piping in inches.

P = Average observed test pressure in pounds per square inches gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

x = The multiplication symbol.

3.05 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.

B. General:
   1. Test pressures shall be as scheduled in Section 40_05_00.01 - Common Work Results for General Piping.
   2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
   3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
   4. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Visible leaks test:
   1. Subject piping under test to specified pressure measured at the lowest end.
   2. Fill piping section under test slowly with water while venting air:
      a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
   4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
   1. Pressure test piping after completion of visible leaks test.

2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
    a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours, and no damage to piping and appurtenances has occurred.
    b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

E. Optional joint test:
1. When joint testing is allowed by note in the Piping Schedule, the procedure shall be as follows:
    a. Joint testing will be allowed only for low head pressure piping.
    b. Joint testing does not replace and is not in lieu of any testing of the piping system or trust restraints.
2. Joint testing may be performed with water or air.
3. Joint test piping after completion of backfill and compaction to the top of the trench.
4. Joint testing with water:
    a. Measure test pressure at the invert of the pipe. Apply pressure of 4 feet plus the inside diameter of the pipe in water column within 0.20 feet in water column.
    b. Maintain test pressure for 1 minute.
    c. Base the allowable leakage per joint on 80 gallons per inch nominal diameter, per mile of piping, per 24 hours equally distributed to the actual number of joints per mile for the type of piping.
    d. Consider the pressure test to be complete when makeup water added is less than the allowable leakage.
    e. Successful completion of the joint test with water shall have been achieved when the observed leakage is equal or less than the allowable leakage.
5. Joint testing with air:
    a. Apply test pressure of 3 pounds per square inch gauge with a maximum variation of plus 0.20 and minus 0.00 pounds per square inch.
    b. Maintain test pressure for 2 minutes.
    c. Consider the pressure test to be complete when the test pressure does not drop below 2.7 pounds per square inch for the duration of the test.

END OF SECTION

SECTION 40_05_06.01

PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Piping specialties, including:
      a. Flexible rubber connections.
      b. Rubber expansion joints.
      c. Pipe saddles.
      d. Tapping sleeves.
      e. Spray nozzles.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.

B. American Water Works Association (AWWA):
   1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
   2. C151 - Standard for Ductile-Iron Pipe, Centrifugally Cast.

C. ASTM International (ASTM):
   1. A148 - Standard Specification for Steel Castings, High-Strength, for Structural Purposes.
   2. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   3. A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   4. A536 - Standard Specification for Ductile Iron Castings.

D. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects, Includes Errata.
   2. 372 - Drinking Water System Components - Lead Content.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures and Section 01_60_00 - Product Requirements.

B. Product data:
   1. For each piping product in this Section as applicable:
      a. Design features.
      b. Load capacities.

c. Material designations by UNS alloy number or ASTM Specification and Grade.
d. Data needed to verify compliance with the Specifications.
e. Catalog data.
f. Clearly mark Submittal information to show specific items, materials, and accessories or options being furnished.

C. Installation instructions:
1. Provide manufacturer's installation instructions.

D. Calculations:
1. Provide calculations in accordance with NSF 372 for materials in contact with drinking water.

E. Manufacturer's Certificate of Installation as specified in Section 01_75_17 - Commissioning:
1. Provide as specified in this Section.

1.04 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements.

B. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.

2.02 FLEXIBLE RUBBER CONNECTIONS

A. Manufacturers: One of the following or equal:
1. Mercer Rubber Co., Type 150 Vibraflex.
2. Red Valve Co., Inc., Part Number P-5.

B. Provide flexible rubber connections with 3/8-inch thick neoprene rubber tube with full-faced flanged ends suitable to withstand a pressure of 150 pounds per square inch gauge.

C. Provide complete flexible rubber connections, including galvanized retaining rings and control rods.

2.03 RUBBER EXPANSION JOINTS

A. Manufacturers: One of the following or equal:
1. Mercer Rubber Co., Style 500 or 700.
2. Proco Products, Inc., Series 230 or 240.
3. Red Valve Co., Inc., Type J-1.

B. Provide rubber expansion joints complete with control units and split retaining rings.

C. Design:
   1. Neoprene rubber, reinforced with embedded steel rings, and a strong synthetic fabric.
   2. Expansion rings, suitable for pressures of at least 125 pounds per square inch gauge, except as follows:
      a. Expansion joints in pump suction piping and where indicated on the Drawings suitable for minimum 90 pounds per square inch gauge pressure, and minimum 30 inches mercury vacuum.
      b. Ends of expansion joints: 150 pound ASME flanges with drilling to match that of the piping.
   3. Bolts, nuts, control rods/plates, and retaining rings shall be galvanized steel unless otherwise specified.
   4. Bolts, nuts, control rods/plates, and retaining rings for low pressure air systems provide materials matching the piping system.
   5. Bolts, nuts, control rods/plates, and retaining rings submerged in water or wastewater, buried, in wet vaults or structures, adjacent to wet walls, or above open water-containing structures shall be Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts, and in accordance with ASTM A194, Grade 8M, for nuts.

D. For blowers: Butyl type rubber formulated for service application and for maximum temperature of 250 degrees Fahrenheit, suitable for minimum 40 pounds per square inch gauge pressure, and minimum 15 inches mercury vacuum.

2.04 PIPE SADDLES

A. For ductile iron pipe:
   1. Double strap brass type.
   2. Manufacturers: One of the following or equal:
      a. A.Y. McDonald, Style 3825.
      b. The Ford Meter Box Company, Style 202B.
      c. Mueller Company, Style BR2B.
   3. Materials:
      a. Pipe saddle body, straps, and nuts: Brass or silicon bronze.
      b. Gaskets: Rubber.

B. For PVC C900 or C905 pipe:
   1. Manufacturers: One of the following or equal:
      a. Romac Industries, Inc., Style 202S.
      b. Smith-Blair, Inc., Style 317.
   2. Materials:
      a. Pipe saddles: Ductile iron with fusion bonded epoxy finish.
      b. Straps, bolts, and nuts: Type 304 stainless steel with Teflon™ coating on nuts.
      c. Gaskets: Rubber.

2.05 TAPPING SLEEVES

A. Manufacturers: One of the following or equal:
   1. Romac Industries, Inc., Style FTS 420.
   2. Smith-Blair, Inc., Style 622.

B. Materials:
   1. Tapping sleeves: Steel construction.
   2. Bolts and nuts: Type 304 stainless steel.
   3. Nuts: Teflon™ coated.
   4. Gaskets: Rubber.
   5. Size of tapped boss: As indicated on the Drawings.

2.06 SPRAY NOZZLES

A. Manufacturers: One of the following or equal:
   1. Evoqua Water Technologies.
   2. Lechler USA, Series 564.

B. Design:
   1. Operating pressure 10 pounds per square inch gauge, at which pressure each nozzle discharges not less than 3.5 gallons per minute, or more than 5.0 gallons per minute.
      a. Spray: Flat, heavy sheet, fan with uniform distribution.
      b. Fan width at the water surface not less than 6.5 feet at 10 pounds per square inch gauge.
      c. Spray deflection with a replaceable deflector insert free to rotate away from the orifice opening and mechanically locked in place and counterweighted.
   2. Structurally suitable for pressure up to 200 pounds per square inch gauge.
   3. Easy flush type.

C. Materials:
   1. Leaded bronze.
   2. Provided with 1/4 inch NPT connection, and the orifice diameter not less than 1/4 inch.
   3. Replaceable spray deflector: Neoprene rubber.

2.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements.

B. Drawings supersede conflicts with this Section.

C. Bellows type expansion joints and vibration control joints:
   1. Protect joints against damage during pressure test.

3.02 INSTALLATION

A. Pipe saddles:
   1. Coat threads on bolts with anti-gall coating prior to installation.

B. Tapping sleeves:
   1. Verify existing pipe material and outer diameter prior to ordering materials.
   2. Large diameter pipe:
      a. Verify the existence of lining material.
      b. Verify lining material type.
      c. Repair lining after hot tap operations are complete with similar lining or equal.
      d. Demonstrate ability to accomplish hot tap by staging a dry run simulation of the procedure prior to the initiation of the hot tap procedure.
         1) Walk through each step of the hot tap installation, and show the Engineer every component needed to install the hot tap, including, but not limited to, tools and materials, to ensure that the required components are on site and in place prior to beginning the procedure.
   3. Coat threads on bolts with anti-gall coating prior to installation.

C. Spray nozzles:
   1. Install so that elevation of the nozzles is 18 inches above the water surface.

3.03 FIELD QUALITY CONTROL

A. Manufacturer services:
   1. Required only for:
      a. Transition couplings.
      b. Tapping sleeves for large diameter pipe.
   2. Provide Manufacturer’s Certificate of Installation.

B. Field testing:
   1. As specified in Section 40_05_00.01 - Common Work Results for General Piping.
   2. Protect bellows type expansion joints and vibration control joints.

END OF SECTION

SECTION 40_05_06.03

PIPE COUPLINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pipe couplings for ductile iron piping.
   2. Pipe couplings for carbon steel piping.
   3. Pipe couplings for stainless steel piping.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. American Society of Mechanical Engineers (ASME):
   1. B31.1 - Power Piping.
   2. B31.9 - Building Services Piping.

C. American Water Works Association (AWWA):
   1. C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   2. C207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In.
   3. C213 - Standard for Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
   4. C219 - Bolted, Sleeve-Type Couplings For Plain-End Pipe.
   5. C606 - Standard for Grooved and Shouldered Joints.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A193 - Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   4. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   5. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   6. A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/9 ksi Minimum Tensile Strength, General Use.
   7. A536 - Standard Specification for Ductile Iron Castings.
   8. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   9. A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.

10. C425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
11. C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
12. C564 - Standard Specification for Rubber Gasket for Cast Iron Pipe and Fittings.
13. C1173 - Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
14. D1869 - Standard Specification for Rubber Rings for Asbestos-Cement Pipe.
15. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
16. D5926 - Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems.
17. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
18. F594 - Standard Specification for Stainless Steel Nuts.
19. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

E. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.
2. 372 - Drinking Water System Components - Lead Content.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
1. For each product in this Section as applicable:
   a. Design features.
   b. Load capacities.
   c. Material designations by UNS alloy number or ASTM specification and grade.
   d. Data needed to verify compliance with the Specifications.
   e. Catalog data.
   f. Clearly mark Submittal information to show specific items, materials, and accessories or options being furnished.

C. Calculations:
1. Provide calculations in accordance with NSF 372 for materials in contact with drinking water.

1.04 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements:
   1. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.

B. Known acceptable manufacturers are listed by specific products.

C. Provide references as specified in this Section by specific product.

D. Manufacturer's representatives requirements as specified in Section 01_75_17 - Commissioning and this Section by specific product.

E. Gaskets for flexible couplings and flanged coupling adapters:
   1. Provide gasket materials for piping applications as follows:
      a. Low-pressure and high-pressure air, steam, hot water: EPDM.
      b. All other piping applications: Neoprene rubber or Buna-N.

F. Exterior coatings for underground and submerged applications:
   1. Manufacturers: One of the following or equal:
      a. Kop-Coat Co., Inc., Bitumastic Number 50.
      b. Tapecoat Co., Inc., T.C. Mastic.
   2. Thickness: Minimum 0.040 inch.

2.02 PIPE COUPLINGS FOR DUCTILE IRON PIPING

A. Dismantling joints:
   1. Manufacturers: One of the following or equal:
      a. Romac Ind., Inc., Style DJ400.
      b. Smith-Blair, Inc., Series 975.
   2. Materials:
      a. Flanged spool: AWWA C207 steel pipe:
         1) ASTM A53 for sizes 3 inches to 12 inches.
         2) ASTM A36 for sizes 14 inches to 72 inches.
      b. End ring and body:
         1) For sizes 3 inches to 12 inches: Ductile iron in accordance with ASTM A536.
         2) For sizes 14 inches to 72 inches: Steel in accordance with ASTM A36 or A53.
      c. Follower ring: Ductile iron in accordance with ASTM A536.
      d. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
      e. Tie rods: High tensile steel in accordance with ASTM A193 Grade B7.

3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

B. Equipment connection fittings (ECF):
   1. Manufacturers: The following or equal:
      a. Romac Ind., Inc., Style ECF400.
   2. Design:
      a. In accordance with AWWA C219.
      b. Suitable for minimum 150 pounds per square inch working pressure.
      c. Consist of 2 flanged coupling adapters, plain end section of pipe, thrust restraint rods, and associated fittings designed to transmit thrust without transmitting shear to the thrust restraint rods and without compromising provision for accommodating angular and parallel misalignment.
         1) Face to face length adjustment:
            a) For sizes 3 inches to 12 inches: 2 inches.
            b) For sizes 14 inches to 72 inches: 3 inches.
      d. Provide both lateral and angular misalignment adjustment between flanges.
         1) Shall accommodate a minimum of 1/4-inch lateral offset and 2 degrees deflection.
      e. Provide full pressure thrust restraint between flanges.
         1) Thrust rod:
            a) Selected to provide sufficient freedom of movement through all bolt holes to allow unrestricted maximum adjustment of equipment connection fittings.
            b) No transmission of any shear to the thrust rods.
            c) Allows full development of thrust restraint at thrust rod tension take-ups.
            d) Number and diameter selected as recommended by the manufacturer for the working pressure of the coupling.
   3. Materials:
      a. Flanged spool: AWWA C207 steel pipe:
         1) ASTM A53 for sizes 3 inches to 12 inches.
         2) ASTM A36 for sizes 14 inches to 72 inches.
      b. End ring and body:
         1) For sizes 3 inches to 12 inches: Ductile iron in accordance with ASTM A536.
         2) For sizes 14 inches to 72 inches: Steel in accordance with ASTM A36 or A53.
      c. Bolts and hex nuts:
         1) Aboveground: Type 316 stainless steel bolts in accordance with ASTM F593.
      d. Tie rods: Type 316 stainless steel in accordance with ASTM A193 B8M.
      e. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
      f. Harness lugs: ASTM A36 steel.
      g. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

C. Flanged coupling adapters: 12-inch size and smaller:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 227.
      b. Romac Ind., Inc., Style FCA501.
      c. Smith-Blair, Inc., Series 912.
   2. Materials:
      a. Flanged body: Ductile iron in accordance with ASTM A536.
      b. Follower ring: Ductile iron in accordance with ASTM A536.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

D. Flanged coupling adapters: Greater than 12-inch size:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 128-W.
      b. Romac Ind., Inc., Style FC400.
      c. Smith-Blair, Inc., Series 913.
   2. Materials:
      a. Flange and flanged body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      b. Follower ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

E. Flexible couplings:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 253.
      b. Romac Ind., Inc., Style 501.
      c. Smith-Blair, Inc., Series 441.
   2. Materials:
      a. Center rings: Ductile iron in accordance with ASTM A536.
      b. Follower rings: Ductile iron in accordance with ASTM A536.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel in accordance with ASTM F593.

3. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
4. Center sleeve dimensions: Provide center sleeves with lengths in accordance with following table:

Nominal Pipe Size	Sleeve Length
3 inch and smaller	Manufacturer's standard
4 inch through 8 inch	7 inches
10 inch through 14 inch	12 inches
Greater than 16 inch	Use steel flexible coupling per pipe couplings for steel piping

F. Flexible couplings (gravity flow):
1. Manufacturers: The following or equal:
   a. Fernco Flexible Coupling.
2. Materials:
   a. In accordance with ASTM D5926, ASTM C1173, and applicable portions of ASTM C443, C425, C564, and D1869.
3. Requirements:
   a. In underground and underwater installations, couplings shall be corrosion resistant or coated with a fusion applied epoxy coating in accordance with AWWA C213.
   b. Bolts and hardware shall be stainless steel 18-8 Type 316 epoxy coated alloy hardware.

G. Restrained flange coupling adapter:
1. Manufacturers: One of the following or equal:
   a. Romac Ind., Inc., Style RFCA.
   b. Star Pipe Products, 3200 StarFlange™.
2. Materials:
   a. Flange and flanged body: Ductile iron in accordance with ASTM A536.
   b. Follower ring: Lug type restraint system.
      1) Follower ring: Ductile iron in accordance with ASTM A536.
      2) Restraining lugs: Ductile iron in accordance with ASTM A536.
         a) Designed to contact the pipe and apply forces evenly.
      3) Restraining bolts:
         a) Ductile iron in accordance with ASTM A536.
         b) Bolt heads shall be designed to twist off when the proper torque has been applied.
   c. Bolts and hex nuts:
      1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
      2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
5. Angular deflection: Restrained flange coupling adapter must allow angular deflection after assembly.

H. Grooved joint couplings:
    1. Manufacturers: The following or equal:
        a. Victaulic Co., Series 31 or equal.
    2. Materials:
        a. Housings: Ductile iron in accordance with ASTM A536.
        b. Gasket:
            1) FlushSeal® type, or equal. Elastomer in accordance with ASTM D2000.
            2) Neoprene or Buna-N.
        c. Bolts and nuts: Electroplated steel in accordance with ASTM A449.
        d. Coating: As specified in Section 09_96_01 - High-Performance Coatings.
    3. For use with rigid or flexible radius grooved components in accordance with AWWA C606.
    4. For connection to IPS steel pipe sizes: Victaulic Style 307.

2.03 PIPE COUPLINGS FOR CARBON STEEL PIPING

A. Dismantling joints:
    1. Manufacturers: One of the following or equal:
        a. Romac Ind., Inc., Style DJ400.
        b. Smith-Blair, Inc., Series 975.
    2. Materials:
        a. Flanged spool:
            1) AWWA C207 Schedule 40 pipe in accordance with ASTM A53 for sizes 3 inches to 12 inches.
            2) Steel for pipe in accordance with ASTM A36 or A53 for sizes 14 inches to 72 inches.
        b. End ring and body:
            1) For sizes 3 inches to 12 inches: Ductile iron in accordance with ASTM A536.
            2) For sizes 14 inches to 72 inches: Steel in accordance with ASTM A36.
        c. Follower ring: Ductile iron in accordance with ASTM A536 or steel in accordance with ASTM A36 or A576.
        d. Bolts and hex nuts:
            1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
            2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
        e. Tie rods: High tensile steel in accordance with ASTM A193 Grade B7.
    3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
    4. Coating and lining: Fusion bonded epoxy certified in accordance with NSF 61.

B. Flanged coupling adapters:
    1. Manufacturers: One of the following or equal:
        a. Dresser, Inc., Style 128-W.
        b. Romac Ind., Inc., Style FCA501 (10 inch and smaller) or Style FC400 (12 inch and larger).
        c. Smith-Blair, Inc., Series 913.

2. Materials:
    a. Flange and flanged body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
    b. Follower ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
    c. Bolts and hex nuts:
        1) Aboveground: High-strength, low-alloy steel in accordance with AWWA C111.
        2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

C. Flexible couplings:
1. Manufacturers: One of the following or equal:
    a. Dresser, Inc., Style 38.
    b. Romac Ind., Inc., Style 511 or Style 400.
    c. Smith-Blair, Inc., Series 411.
2. Materials:
    a. Center sleeve and follower flanges: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
    b. Bolts and hex nuts:
        1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
        2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
3. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
4. Center sleeve dimensions: Provide center sleeves with lengths in accordance with the following table:

Nominal Pipe Diameter	Sleeve Length
2-1/2 inch and smaller	Manufacturer's standard
3 inch through 6 inch	7 inch
8 inch through 14 inch	7 inch
Greater than 14 inches	10 inch

D. Restrained flange coupling adapters:
1. Manufacturers: One of the following or equal:
    a. Romac Ind. Inc., Style RFCA.
    b. Star Pipe Products, 3200 StarFlange™.
2. Materials:
    a. Flange and flanged body: Ductile iron in accordance with ASTM A536.
    b. Follower ring: Lug type restraint system.
        1) Follower ring: Ductile iron in accordance with ASTM A536.
        2) Restraining lugs: Ductile iron in accordance with ASTM A536.
            a) Designed to contact the pipe and apply forces evenly.

3) Restraining bolts: Ductile iron in accordance with ASTM A536. Bolt heads shall be designed to twist off when the proper torque has been applied.

c. Bolts and hex nuts:

1) Aboveground: High-strength, low-alloy steel in accordance with AWWA C111.

2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.

3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.

4. Coating and lining: Manufacturer's standard fusion bonded epoxy certified in accordance with NSF 61.

E. Grooved joint couplings:

1. Model numbers from one manufacturer are shown to indicate type only. Equivalent products of other manufacturers may be submitted for approval.

2. Coating: As specified in Section 09_96_01 - High-Performance Coatings.

3. Sizes through 12 inch:

a. Rigid type:

1) Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ASME B31.1 and B31.9.

2) 2 inch through 6 inch: Installation-ready, for direct stab installation without field disassembly, with grade EHP gasket rated to 250 degrees Fahrenheit.

3) Manufacturers: One of the following or equal:

a) Victaulic Style 107.

b) Victaulic Zero-Flex Style 07.

b. Flexible type:

1) For use in locations where vibration attenuation and stress relief are required.

2) 3 flexible couplings may be used in lieu of a flexible connector.

3) Couplings shall be placed in close proximity to the source of the vibration.

4) Manufacturers: The following or equal:

a) Victaulic Style 77.

c. Flange adapter:

1) Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.

2) Manufacturers: The following or equal:

a) Victaulic Style 741.

4. Sizes 14 inch through 24 inch:

a. Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.

b. Rigid type:

1) Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ASME B31.1 and B31.9.

2) Manufacturers: The following or equal:

a) Victaulic Style W07.

c. Flexible type:
1) Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement.
2) Manufacturers: The following or equal:
a) Victaulic Style W77.
d. Flange adapter:
1) Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.
2) Manufacturers: The following or equal:
a) Victaulic Style W741.
5. For sizes 30 inch and larger:
a. Manufacturers: The following or equal:
1) Victaulic Style AGS multiple-segment housing may be used.

2.04 PIPE COUPLINGS FOR STAINLESS STEEL PIPING

A. Flexible couplings:
1. Manufacturers: The following or equal:
a. Dresser, Inc., Style 38.

B. Grooved joint couplings:
1. Manufacturers: The following or equal:
a. Victaulic Co.
2. Materials:
a. Housings:
1) Ductile iron in accordance with ASTM A536.
2) Stainless steel in accordance with ASTM A351.
b. Gasket: Elastomer in accordance with ASTM D2000.
c. Bolts and nuts:
1) Electroplated steel in accordance with ASTM A449.
2) Stainless steel in accordance with ASTM F593.
3. Rigid type:
a. Victaulic Style 89 and W89 (ductile iron housings).
b. Victaulic Style 489 (stainless steel housings).
4. Flexible type: Victaulic Style 77S.

PART 3 EXECUTION

3.01 INSTALLATION

A. In underground and underwater installations, coat the exterior of coupling with a protective coating in accordance with the manufacturer’s instructions.

B. Joints and flexible connections shall be installed centered with no angular deflection unless otherwise indicated on the Drawings.

C. Flexible couplings and flange coupling adapters: Install with gap between pipe ends in accordance with the following table unless a greater gap is indicated on the Drawings. Maximum gap tolerance shall be within 1/8 inch.
   1. Install flexible coupling with pipe gap located in middle of center sleeve.
   2. Install flanged coupling adapter with end of plain end pipe in middle of flanged coupling body.

Center Ring Length	Gap Dimension and Tolerance
4 inch through 6 inch	3/8 inch
7 inch	5/8 inch
10 inch and greater	7/8 inch

D. Provide harnesses (tie-downs) for flexible couplings unless otherwise indicated on the Drawings with a written note.
   1. Design harnesses (tie-downs) for the test pressures as specified in the Piping Schedule in Section 40_05_00.01 - Common Work Results for General Piping.

E. Grooved joint couplings:
   1. Grooved ends: Clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
   2. Gaskets: Elastomer grade suitable for the intended service, and molded and produced by the coupling manufacturer.

END OF SECTION

SECTION 40_05_06.10

STRAINERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Strainers.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A420 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service.

B. Society of Automotive Engineers (SAE).

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_00.01 - Common Work Results for General Piping.

PART 2 PRODUCTS

2.01 Y-TYPE STRAINERS

A. Y-type strainers 4 inches and larger in diameter:
   1. Materials:
      a. Bodies: Cast iron or semi-steel.
      b. Ends: Flanged.
      c. Screens: Brass or Type 304 stainless steel.
   2. Suitable for following minimum pressure conditions:
      a. Steam service: 250 pounds per square inch gauge.
      b. Water, oil, and gas service: 200 pounds per square inch gauge.
   3. Perforated screens:
      a. Openings: 0.045 inches.
      b. Active screen opening to pipe area ratio: 2.8, minimum.
      c. Free area: 37 percent minimum.
   4. Manufacturers: One of the following or equal:
      a. Armstrong International Inc., Code A1.
      b. ITT/Hoffman, 460 Series.

B. Y-type strainers less than 4 inches in diameter:
   1. Materials:
      a. Bodies: Cast iron or semi-steel.
      b. Ends: Flanged or threaded.
      c. Screen: Brass or Type 304 stainless steel.
   2. Suitable for maximum pressure of 250 pounds per square inch gauge.
   3. Screens: Perforations: 1/32 inch.
   4. Manufacturers: The following or equal:
      a. Armstrong, Y-Type Strainer.

C. Y-type strainers less than 3 inches in diameter for chemical service:
   1. Materials:
      a. Bodies: PVC.
      b. Ends: Socket end true unions.
      c. Screen: PVC.
      d. Seal material: EPDM.
   2. Suitable for a minimum pressure of 90 pounds per square inch gauge.
   3. Screens: Perforations: 1/16 inch.
   4. Manufacturers: One of the following or equal.
      a. Asahi American.
      b. Hayward Flow Control.
      c. Spears Manufacturing Co.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with the manufacturer’s recommendations.

END OF SECTION

SECTION 40_05_06.55

PIPING INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Insulation for piping and related systems that are not plumbing systems.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Water Works Association (AWWA):
   1. C151 - Ductile-Iron Pipe, Centrifugally Cast.

C. ASTM International (ASTM):
   1. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
   2. B88 - Standard Specification for Seamless Copper Water Tube.
   3. C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   4. C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   5. C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
   6. C547 - Standard Specification for Mineral Fiber Pipe Insulation.
   7. C552 - Standard Specification for Cellular Glass Thermal Insulation.
   8. C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
   9. C929 - Standard Practice for Handling, Transporting, Shipping, Storage, Receiving, and Application of Thermal Insulation Materials for Use in Contact with Austenitic Stainless Steel.
   10. C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   11. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   12. D2310 - Standard Classification of Machine-Made “Fiberglass” (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe.
   13. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   14. E96 - Standard Test Methods for Water Vapor Transmission of Materials.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Buried: Piping that is installed below buildings, foundations, or finish grade, either in soil or encased in concrete in soil.
   2. Concealed: Piping above suspended ceilings and within walls, partitions, shafts, or service spaces and spaces not normally exposed to view but not buried.
   3. Exterior: Piping that is installed outside a building or within a pipe trench or tunnel.
   4. Flame spread and smoke density: Burning characteristics determined in accordance with ASTM E84.
   5. Interior: Piping that is installed inside a building.
   6. K-factor: Thermal conductivity determined in accordance with ASTM C177 or ASTM C518.
   7. Mineral fiber: Fibers manufactured of glass, rock, or slag processed from a molten state, with or without a binder.
   8. Water vapor permeance: Water vapor transmission determined in accordance with ASTM E96 and expressed in units of perm-inch.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 01_60_00 - Product Requirements.

B. Product data:
   1. Insulation properties: Include K-factor, thickness, density, operating temperature limits, tensile strength, compressive strength, moisture absorption, flame spread, and smoke developed in accordance with ASTM E84 and corrosivity to stainless steel piping in accordance with ASTM C795.
   2. Jacket properties: Include covering material, cover thickness, tensile strength, tear strength, permeability in accordance with ASTM E96, flame spread, and smoke developed in accordance with ASTM E84, closure type or devices, and accessories.
   3. Insulating blankets: Include materials, performance characteristics, method of attaching to equipment, listing of locations where insulating blankets will be installed.
   4. Manufacturer’s application instructions: Include assembly and application drawings and detailed instructions.

1.05 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements with additional requirements in Section 46_05_10 - Common Work Results for Mechanical Equipment and Section 23_05_00 - Common Work Results for HVAC.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment and Section 23_05_00 - Common Work Results for HVAC.

B. Provide insulation thickness in inches in accordance with the following table. Insulation thickness shown is nominal. Manufacturing tolerance of 15 percent variation is permissible.

Table 1. Required Insulation Thicknesses (inches)

Service Temperature Range(1)	Nominal Pipe Diameters				
	1 inch and Less	1.25 to 2 inches	2.5 to 4 inches	5 to 10 inches	Over 10 inches
Above 200 degrees Fahrenheit	2.0	2.5	3.0	3.5	3.5
100 to 200 degrees Fahrenheit	1.5	1.5	1.5	2.0	2.5
40 to 100 degrees Fahrenheit	0.5	1.0	1.0	1.5	2.0
Below 40 degrees Fahrenheit	1.0	1.0	1.5	2.0	2.0
Heat Traced Pipes	1.0	1.0	1.0	1.5	2.0

Notes:
(1) As designated in the Insulation Schedule at the end of this Section.

2.03 PIPE INSULATION

A. Insulation types: Provide in accordance with the insulation types listed and scheduled.

B. Type 1:
1. Material: Closed cell elastomeric insulation.
2. Minimum temperature range: -40 degrees Fahrenheit to 220 degrees Fahrenheit.
3. K-factor at 75 degrees Fahrenheit: Not more than 0.27 Btu-inch/hour-square feet-degrees Fahrenheit.
4. Fire ratings:
   a. Flame spread: 25 or less.
   b. Smoke density: 50 or less for insulation thicknesses up to 1.5 inches.
5. Joints: Seal with the manufacturer’s recommended contact adhesive to form a continuous water barrier.
6. Manufacturers: One of the following or equal:
   a. Aeroflex USA Inc., Aerocel® AC.
   b. Armacell, AP Armaflex.

C. Type 2:
   1. Material: Preformed mineral fiberglass insulation made from glass fibers bonded with a thermosetting resin.
      a. In accordance with ASTM C547, Class 1.
      b. Provide with factory installed vapor barrier.
         1) Material: White Kraft paper bound to aluminum foil in accordance with ASTM C1136, Type I.
         2) Longitudinal lap seals: Pressure-sensitive, self-sealing longitudinal lap strip with factory applied adhesive.
         3) Circumferential butt seals: 4-inch wide tape or similar properties or 4-inch wide overlap with adhesive seal.
         4) Permeability: 0.02 perms or lower.
         5) Flame spread rating: 25 or less.
   2. Minimum temperature range: 0 degrees Fahrenheit to 850 degrees Fahrenheit.
   3. K-factor at 75 degrees Fahrenheit: Not more than 0.23 Btu-inch/hour-square feet degrees Fahrenheit.
   4. Maximum moisture absorption, volume percent: 5.
   5. Manufacturers: One of the following or equal:
      a. Johns Manville, Micro-Lok® HP.
      b. Knauf Insulation, Earthwool® Redi-Klad® 1000° Pipe Insulation.
      c. Owens Corning, Fiberglas™ FLEXWRAP® ASJ.

D. Type 3:
   1. Material: Rigid cellular glass in accordance with ASTM C552, Type II.
   2. Temperature range: -450 degrees Fahrenheit to 900 degrees Fahrenheit.
   3. K-factor at 75 degrees Fahrenheit: Not more than 0.32 Btu-inch/hour-square feet-degrees Fahrenheit.
   4. Minimum average density: 7.5 pounds per cubic foot.
   5. Maximum moisture absorption, volume percent: 5.
   6. Minimum compressive strength: 87 pounds per square inch.
   7. Moisture permeability: 0.00 perm-inch.
   8. Manufacturers: The following or equal:
      a. Owens Corning, Foamglas® One™.

2.04 INSULATION JACKETS

A. Type 2:
   1. Material: Ultraviolet-resistant polyvinyl chloride jacketing, 20 mil minimum thickness.
   2. Fire rating: 25 maximum flame spread, smoke developed 50 or less.
   3. Color: White.
   4. Overlap: 1 inch minimum at joints and fittings.
   5. Joint seal: PVC solvent welded or adhesive as recommended by the manufacturer.
   6. Fittings: Factory made with full thickness insulation.
   7. Manufacturers: One of the following or equal:
      a. Johns Manville, Zeston® 2000 PVC.
      b. Proto Corp., LoSMOKE PVC.
      c. Speedline® Corp., Smoke-Safe™ PVC.

2.05 VAPOR BARRIERS

A. Type 1:
   1. Material: White Kraft paper bound to aluminum foil in accordance with ASTM C1136, Type 1.
   2. Permeability: 0.02 perms or lower.
   3. Maximum flame spread rating: 25.
   4. Edge seal: Pressure-sensitive tape lap seal.
   5. Circumferential joints: 4-inch wide tape or 4-inch overlap with adhesive seal.

B. Type 2:
   1. Material: Mastic.
   2. Manufacturers: One of the following or equal:
      a. Benjamin Foster, No. 30-76.
      b. Childers Products CP10/11 VI-CRYL.
      c. Foster Products, 36-10/46-10 Weatherite.
      d. Insul-Coustic, No. I.C.-580.

2.06 RELATED MATERIALS

A. Cover adhesive: Premium adhesive as recommended by the insulation cover supplier for heavy-duty service in corrosive, wet environments. Standard-duty adhesives are not permitted.

2.07 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01_60_00 - Product Requirements.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements.

B. Handle and store insulation for use on stainless steel in accordance with ASTM C929.

3.02 PREPARATION

A. Pressure test piping and complete application of coating system before applying insulation.

B. When piping is to be heat traced, install and functionally test heat tracing before installation of insulation.

C. Before beginning installation of piping insulation, verify that the Engineer has accepted piping tests, pipe coating applications, and heat tracing tests.

3.03 INSULATION SCHEDULE

A. The insulation schedule table below does not include insulation required for plumbing systems. Plumbing systems insulation is specified in Section 22_42_01 - Plumbing Systems.

Table 2. Insulation Schedule

Service Designation[1]	Location[2]	Insulation Type[3]	Jacket Type[3]	Service Temp. °F[4]	Vapor Barrier
Heat Traced Pipes[5]	Exterior	1 or 2	2	N/A	Install on Type 2 insulation

Notes:

(1) Refer to the Pipe Schedule in Section 40_05_00.01 - Common Work Results for General Piping for service designations.
(2) Insulation jackets are not required for interior installations that are concealed. See definitions for description of concealed locations.
(3) Contractor may select from options listed.
(4) Unless noted otherwise, use service temperature range provided in this table to establish insulation thickness as required by Table 1. Required Insulation Thicknesses.
(5) Insulate piping systems that are specified to be heat traced.

3.04 INSTALLATION

A. Install insulation and jacket materials in accordance with the manufacturer's instructions.

B. Apply insulation in a smooth, clean manner with tight and finished smooth joints. Fit insulation tightly against surfaces.
   1. Insulate each continuous run of pipe with full-length sections of insulation with a single piece cut to length to complete the run of pipe.
   2. Do not use cut pieces or scraps to complete the installation.

C. Butt longitudinal and circumferential insulation joints firmly together.

D. Maintain the integrity of vapor barrier jacketing. Do not use staples to hold vapor barrier overlaps in place.

E. Apply sealant or cement when previous applications of adhesives and cement have thoroughly dried.

F. Apply insulation to permit expansion or contraction of pipelines without damage to insulation or jacketing.

G. Fittings:
   1. Insulate fittings by covering with mitered sections of insulation or utilize factory-made prefabricated fitting shapes.
   2. Terminate preformed pipe jackets or covering at sufficient distance from flanges to permit removal of bolts.
   3. Overlap flange and flanged fitting insulation on adjacent pipe covering by at least 2 inches.

H. Valves:
   1. Insulate valves 3 inches in nominal size and larger with removable insulating blankets.
   2. Size blanket to extend up to packing gland only so that replacement of packing does not require removal of insulating blanket.

I. Provide continuous insulation through and over pipe supports and provide protection saddles at supports.

J. Extend insulation against insulation end protection shields or covers so that insulation voids do not exist and provide watertight end seals and covers where insulation terminates.

K. Insulate pipeline strainers to permit removal of strainer basket without disturbing insulation on strainer body.

L. Provide continuous pipe insulation and covering through sleeves or openings in walls and floors. When buried pipe enters a building through a below grade wall or slab penetration, begin insulation system on interior side of penetration.

M. Apply pre-molded pipe insulation with extended legs when used on pipe traced with either tubing or electric cable type.

N. Thermally isolate insulation closure locations (end caps, transitions, etc.) Type 1 or Type 2 jacket installation on piping with potential reach temperatures greater than 150 degrees Fahrenheit.

O. Apply piping identification on jackets as specified in Section 40_05_00.03 - Pipe Identification.

END OF SECTION

SECTION 40_05_07.01

PIPE SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Supports for pipe, fittings, valves, and appurtenances.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   3. A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

B. Manufacturers Standardization Society (MSS):
   1. SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Design features.
   2. Load capacities.
   3. Material designations by UNS alloy number or ASTM Specification and Grade.
   4. Data needed to verify compliance with the Specifications.
   5. Catalog data.
   6. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

1.04 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements.

2.02 MATERIALS

A. General:
   1. Hot dip galvanized:
      a. Fabricate as specified in Section 05_50_00 - Metal Fabrications.
      b. Hot dip after fabrication of support in accordance with ASTM A123.
      c. Repair galvanized surface as specified in Section 05_50_00 - Metal Fabrications.
   2. Stainless steel:
      a. Fabricate as specified in Section 05_50_00 - Metal Fabrications.
      b. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.
      c. At the shop, perform pickling and passivation on all surfaces inside and out in accordance with ASTM A380 or ASTM A967.
      d. Field welding is prohibited unless specifically allowed by the Owner. All field welds shall be passivated.

B. Outdoor areas: Areas exposed to the natural outdoor environment:
   1. On top of Sludge Storage Tank: Type 304 Stainless Steel or Type 304L Stainless Steel.
   2. Other locations: Hot Dip Galvanized.

C. Indoor areas: Areas exposed to an indoor environment including galleries and tunnels:
   1. Hot Dip Galvanized.

D. Submerged, 3 feet or less above water level in a structure, or inside a water bearing structure:
   1. Type 316 Stainless Steel or Type 316L Stainless Steel.

E. Stainless steel piping system:
   1. Type 304 Stainless Steel or Type 304L Stainless Steel.

F. Chemical containment areas and chemical piping:
   1. Not applicable.

G. Fasteners:
   1. As specified in Section 05_50_00 - Metal Fabrications.

2.03 PIPE SUPPORTS

A. Hanger rods: Sized to match suspended pipe hanger, or as indicated on the Drawings:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Bergen-Power, Figure 133.
         2) Nibco-Tolco, Figure 103.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 140.
         2) Bergen-Power, Figure 133.
         3) Cooper B-Line Systems, Inc., Figure B3205.

B. Hanger rods, continuously threaded: Sized to match suspended pipe hanger, or as indicated on the Drawings:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Bergen-Power, Figure 94.
            2) FM Stainless Fasteners.
        b. For steel and ductile iron piping:
            1) Anvil International, Figure 146.
            2) Bergen-Power, Figure 94.

C. Eye bolts:
    1. For stainless steel piping:
        a. Type 316 stainless steel, welded and rated equal to full load capacity of rod.
    2. For all other piping, unless indicated on the Drawings:
        a. Welded and rated equal to full load capacity of rod.

D. Welded eyebolt rod:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) FM Stainless Fasteners.
            2) Nibco-Tolco, Figure 101.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 278.
            2) Bergen-Power, Figure 93.
            3) Cooper B-Line Systems, Inc., Figure B3210.

E. Adjustable ring hangers: MSS SP-58, Type 7 or Type 9 (system dependent):
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Bergen-Power, Figure 100SS.
            2) Nibco-Tolco, Figure 1C.I.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 69.
            2) Cooper B-Line Systems, Inc., Figure B3172.

F. Adjustable clevis hangers: MSS SP-58, Type 1:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Cooper B-Line Systems, Inc., Figure B3100 or B3102.
            2) FM Stainless Fasteners, Figure 60.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 260 or Figure 590.
            2) Bergen-Power, Figure 100.
            3) Cooper B-Line Systems, Inc., Figure B3100 or B3102.

G. Adjustable clevis hangers for insulated pipe: Oversize:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 1A.

b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 300.
2) Bergen-Power, Figure 100EL.
3) Cooper B-Line Systems, Inc. Figure B3108.

H. Single rod hangers for steam pipe: MSS SP-58, Type 43; malleable iron or steel yoke and roller hangers; swivel to allow rotation of yoke on rod:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure B3110.
2) FM Fasteners, Figure 81.
3) Nibco-Tolco, Figure 324.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 181.
2) Cooper B-Line Systems, Inc., Figure B3110.

I. Double rod hangers for steam pipe: MSS SP-58, Type 41:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) FM Stainless Fasteners, Figure 71.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 171.
2) Cooper B-Line Systems, Inc., Figure B3114.

J. Brackets: MSS SP-58, Type 32 with back plate; rated for 1,500 pounds:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure B3066.
2) FM Stainless Fasteners, Figure 98.
3) Nibco-Tolco, Figure 30M.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 195.
2) Cooper B-Line Systems, Inc., Figure B3066.

K. Standard U-bolt: MSS SP-58, Type 24:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure B3188.
2) FM Stainless Fasteners, Figure 37.
3) Nibco-Tolco, Figure 110.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 137.
2) Bergen-Power, Figure 283.
3) Cooper B-Line Systems, Inc., Figure B3188.

L. Riser clamps: MSS SP-58, Type 8:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure B3373.
2) FM Stainless Fasteners, Figure 61.

b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 261.
2) Bergen-Power, Figure 126.
3) Cooper B-Line Systems, Inc., Figure B3373.

M. Pipe clamps: MSS SP-58, Type 4:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure 3140.
2) Nibco-Tolco, Figure 4.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 212.
2) Bergen-Power, Figure 175.
3) Cooper B-Line Systems, Inc., Figure B3140.

N. Adjustable offset pipe clamp:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure B3149.
2) FM Stainless Fasteners, Figure 63.
3) Nibco-Tolco, Figure 4.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 100.
2) Cooper B-Line Systems, Inc., Figure B3149.

O. Offset pipe clamp:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure 3148.
2) Nibco-Tolco, Figure 8.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 103.
2) Cooper B-Line Systems, Inc., Figure B3148.

P. Floor stand or stanchion saddles: MSS SP-58, Type 37. Provided with U-bolt hold down yokes:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) FM Stainless Fasteners, Figure 59.
2) Nibco-Tolco, Figure 318.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 259.
2) Bergen-Power, Figure 125.
3) Cooper B-Line Systems, Inc., Figure B3090.
c. Threaded pipe stand support stanchion. Match pipe support material:
1) Anvil International, Figure 63T.
2) Bergen-Power, Figure 138.
3) Cooper B-Line Systems Inc., Figure B3088ST.

Q. Spring hangers:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Bergen-Power, Figure 920.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure B-268, Type G.
         2) Bergen-Power, Figure 920.

R. One hole pipe clamps:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping: Engineer knows of no product.
      b. For all other piping:
         1) Anvil International, Figure 126.
         2) Carpenter & Paterson, Figure 237S.

S. Welded beam attachment: MSS SP-58, Type 22:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Cooper B-Line Systems, Inc., Figure 3083.
         2) Nibco-Tolco, Figure 304.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 66.
         2) Bergen-Power, Figure 113A or 113B.
         3) Cooper B-Line Systems, Inc., Figure B3083.

T. Heavy pipe clamp: MSS SP-58, Type 4:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 4H.
      b. For all other piping, unless otherwise indicated on the Drawings:
         1) Anvil International, Figure 216.
         2) Bergen-Power, Figure 298.

U. PTFE pipe slide assembly: MSS SP-58, Type 35 with lateral and vertical restraint:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 426.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 257, Type 3.
         2) Cooper B-Line Systems, Inc., Figure B3893.

V. Anchor bolts, concrete anchors, concrete inserts, powder-actuated fasteners, and sleeve anchors: As specified in Section 05_12_00 - Structural Steel Framing.

2.04 THERMAL PIPE HANGER SHIELD

A. Provided at hanger, support, and guide locations on pipe requiring insulation.

B. Consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer.

C. Same thickness as the piping system insulation specified in Section 40_05_06.55 - Piping Insulation.

D. Standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems.

E. Stainless steel band clamps shall be used where specified to protect against slippage between the pipe wall and the thermal shield.

F. Standard shield:
   1. Insulation:
      a. Hydrous calcium silicate, high density, waterproof.
      b. Compressive strength: 100 pounds per square inch average.
      c. Flexural strength: 75 pounds per square inch average.
      d. K factor: 0.38 at 100 degrees Fahrenheit mean.
      e. Temperature range: 20 degrees Fahrenheit to 500 degrees Fahrenheit.
   2. Steel jacket:
      a. Jacket shall be galvanized steel.
      b. Gauge shall be the manufacturer's standard supplied for the given pipe size.
   3. Connection:
      a. Shield shall have butt connection to pipe insulation.
      b. Steel jacket and insulation ends shall be flush.

G. Vapor barrier shield:
   1. Insulation:
      a. Hydrous calcium silicate, high density, waterproof.
      b. Compressive strength: 100 pounds per square inch average.
      c. Flexural strength: 75 pounds per square inch average.
      d. K factor: 0.38 at 100 degrees Fahrenheit mean.
      e. Temperature range: 20 degrees Fahrenheit to 500 degrees Fahrenheit.
   2. Steel jacket:
      a. Jacket shall be of galvanized steel.
      b. Gauge shall be the manufacturer's standard supplied for the given pipe size.
   3. Connection:
      a. Shield shall have butt connection to pipe insulation.

H. Insulation shall extend 1 inch each side of steel jacket for vapor tight connection to the pipe insulation vapor barrier.

PART 3 EXECUTION

3.01 INSTALLATION

A. Support, suspend, or anchor exposed pipe, fittings, valves, and appurtenances to prevent sagging, overstressing, or movement of piping; and to prevent thrusts or loads on or against connected pumps, blowers, and other equipment.

B. Field verify support location, orientation, and configuration to eliminate interferences prior to fabrication of supports.

C. Carefully determine locations of inserts. Anchor to formwork prior to placing concrete.

D. Use flush shells only where indicated on the Drawings.

E. Do not use anchors relying on deformation of lead alloy.

F. Do not use powder-actuated fasteners for securing metallic conduit or steel pipe larger than 1 inch to concrete, masonry, or wood.

G. Suspend pipe hangers from hanger rods and secure with double nuts.

H. Install continuously threaded hanger rods only where indicated on the Drawings.

I. Use adjustable ring hangers or adjustable clevis hangers for 4-inch and smaller diameter pipe.

J. Use adjustable clevis hangers for pipe larger than 4 inches in diameter.

K. Secure pipes with double nutted U-bolts or suspend pipes from hanger rods and hangers.
   1. For stainless steel piping, use stainless steel U-bolts.
   2. For all other piping, use galvanized U-bolts.

L. Support spacing:
   1. Support 2-inch and smaller piping on horizontal and vertical runs at maximum 5 feet on center, unless otherwise specified.
   2. Support larger than 2-inch piping on horizontal and vertical runs at maximum 10 feet on center, unless otherwise specified.
   3. Support exposed polyvinyl chloride and other plastic pipes at maximum 5 feet on center, regardless of size.
   4. Support tubing, PVC pipe 1-inch and smaller, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose and tubing at intervals close enough to prevent sagging greater than 1/4-inch between supports.
   5. Do not suspend or support valves, pipe and fittings from another pipe or conduit.

M. Install supports at:
   1. Any change in direction.
   2. Both sides of flexible pipe connections.
   3. Base of risers.
   4. Floor penetrations.
   5. Connections to pumps, blowers, and other equipment.
   6. Valves and appurtenances.

N. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves.

O. Anchor plastic pipe between expansion loops and direction changes to prevent axial movement through anchors.

P. Provide elbows or tees supported from floors with base fittings where indicated on the Drawings.

Q. Support base fittings with metal supports or, when indicated on the Drawings, support on concrete piers.

R. Do not use chains, plumbers' straps, wire, or similar devices for permanently suspending, supporting, or restraining pipes.

S. Support plumbing drainage and vents in accordance with plumbing code as specified in Section 01_41_00 - Regulatory Requirements.

T. Supports, clamps, brackets, and portions of support system bearing against copper pipe: Copper plated, copper throughout, or isolated with neoprene or polyvinyl chloride tape.

U. Where pipe is insulated, install over-sized supports and hangers.

V. Install thermal pipe shield in accordance with MSS SP-58, Type 40 on pipe supports for insulated pipes.

W. Install riser clamps at floor penetrations and where indicated on the Drawings.

X. Coat support system components as specified in Section 09_96_01 - High-Performance Coatings.

END OF SECTION

SECTION 40_05_07.03

PREFORMED CHANNEL PIPE SUPPORT SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preformed channel pipe support system consisting of preformed channels, fittings, straps, and fasteners engineered to support piping.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC).

B. American Iron and Steel Institute (AISI).

C. Manufacturer's Standardization Society (MSS):
   1. SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data.

1.04 QUALITY ASSURANCE

A. Design preformed channel pipe support system for loads in accordance with applicable provisions of:
   1. AISC Manual of Steel Construction.
   2. AISI Cold-Formed Steel Design Manual.

B. Product standards:
   1. Pipe support materials: In accordance with MSS SP-58.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fabricate preformed channel pipe support system using, as a minimum, parts specified below and meeting the requirements specified under Design Criteria.
   1. Manufacturers: One of the following or equal:
      a. Unistrut, Series P1000 or P1001; P5500 or P5501.
      b. Allied Support Systems, Power Strut, Figure PS-200 or PS-200 2TS; PS-150 or PS-150 2TS.
      c. Cooper Ind., B-Line, Channel Type B22 or B22A; B12 or B12A.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Design responsibility:
   1. The manufacturer of the preformed channel pipe support system is responsible for the design of the support system.
   2. Prepare design calculations utilizing the design criteria included in these Specifications.
   3. Prepare detailed shop drawings illustrating the layout of the support system and identifying the components of the support system.

B. Design criteria:
   1. Include live, dead, and seismic loads associated with piping, valves, and appurtenances. Consider the content of the pipes in load calculations.
   2. Minimum gauge thickness: 12-gauge.
   3. Allowable stress of channels:
      a. Steel channels: The lesser of 25,000 pounds per square inch, or 0.66 times yield stress of steel.
      b. Stainless steel channels: 0.66 times the yield stress of the stainless steel alloy.
   4. Maximum deflection: 1/240 of span.
   5. Allowable column loads: As recommended by manufacturer in published instruction for column's unsupported height and "K" value for calculating effective column length of not less than 1.0.
   6. Future loads:
      a. Support systems indicated on the Drawings may include spaces intended to accommodate future pipes.
      b. Assume such spaces are occupied by 6-inch diameter ductile iron pipes. Only the number of pipes that would physically fit into the space need be considered.
      c. Include the weight of the pipe contents in determining future loads. Assume pipe contents are water.
   7. Seismic design criteria: As specified in Section 01_81_50 - Design Criteria as specified for mechanical equipment.
   8. Spacing of supports: As required to comply with design requirements but not more than 5 feet.

C. Supports below the top of walls of water bearing structures: Use Type 316 stainless steel for support system components.
   1. Supports in other locations: Use hot-dipped galvanized components unless other materials are specifically indicated on the Drawings.

2.03 ACCESSORIES

A. Preformed channel concrete inserts: Minimum 12 inches long:
   1. Manufacturers: One of the following or equal:
      a. Unistrut, Series P-3200.
      b. Allied Support Systems, Figure 282.
      c. Cooper Ind., B-Line Series B32I.

B. 90-degree angle fittings:
   1. Manufacturers: One of the following or equal:
      a. Unistrut, P1026.
      b. Allied Support Systems, Power Strut, P603.

C. Pipe straps:
   1. For pipes 8 inches in diameter and smaller: Use 2-piece universal strap with slotted hex head screw and nut.
      a. Manufacturers: One of the following or equal:
         1) Unistrut, Series P1109 through P1126.
         2) Allied Support Systems, PS1100.
         3) Cooper Ind., B-Line Series B2000.
   2. For pipes greater than 8 inches in diameter: Unless different material is otherwise indicated on the Drawings use 1-piece 1-inch wide by 1/8-inch thick steel strap, hot-dip galvanized after fabrication.
   3. For stainless steel pipes: Use type of strap required for the pipe sizes specified above, but use Type 316 stainless steel materials.

D. Prefabricated double channel bracket:
   1. Manufacturers: One of the following or equal:
      a. Unistrut, P2542-P2546.
      b. Cooper Ind., B-Line Series B297.

E. Touch-up paint for galvanized surfaces:
   1. Manufacturers: The following or equal:
      a. Galvinox, Galvo-Weld.

F. Touch-up paint for painted surfaces: Same formulation as factory paint.

G. Cushion strip:
   1. For solvent welded plastic pipes in elevated temperatures, use a thermoplastic elastomer, cushion wrap designed for use from -50 degrees Fahrenheit to 275 degrees Fahrenheit. Contractor to add a cushion strip at each pipe support strap that meets this criteria.
      a. Manufacturers: One of the following or equal:
         1) Anvil, AS 3795.
         2) Unistrut, P2600 Unicushion.

2.04 FABRICATION

A. Hot-dip galvanize support system components after fabrication to required length and shape.

B. Do not galvanize or paint stainless steel components.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install preformed channel concrete inserts for vertical support, quantity based on manufacturer's structural design calculations.

B. Fasten preformed channel pipe supports to existing walls using Z-fittings and concrete anchors as indicated on the Drawings.

C. Fasten preformed channel pipe supports to preformed channel concrete inserts embedded in ceiling using U-shaped fittings.

D. Suspend threaded rods from concrete inserts embedded in ceiling. Support preformed channel pipe supports with threaded rods.

E. Touchup cut or damaged galvanized surfaces.

F. Prevent contact between pipes and support components of dissimilar metals. Utilize rubber coated, plastic coated, or vinyl coated components, stainless steel components, or wrap pipe with PVC or polyethylene tape.

G. Install support as near as possible to concentrated loads.

H. Install support within 2 feet of horizontal and vertical changes in pipe alignment.

I. Adjust supports or install shims to obtain specified slope or elevation.

END OF SECTION

SECTION 40_05_17.05

COPPER WATER TUBE: SEAMLESS, ASTM B88

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Copper water tube-seamless, ASTM B88.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   2. B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

B. ASTM International (ASTM):
   1. A536 - Standard Specification for Ductile Iron Castings.
   2. B32 - Standard Specification for Solder Metal.
   3. B88 - Standard Specification for Seamless Copper Water Tube.
   4. B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
   5. B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fitting.

C. International Association of Plumbing and Mechanical Officials (IAPMO):
   1. IS 3 - Installation Standard for Copper Plumbing Tube, Pipe and Fittings.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_00.01 - Common Work Results for General Piping.

PART 2 PRODUCTS

2.01 MATERIALS

A. Plumbing requirements: As specified in Section 22_42_01 - Plumbing Systems.

B. Seamless copper water tube:
   1. Type: ASTM B88:
      a. Exposed copper piping or tubing: Type L hard-drawn, rigid.
      b. Copper tubing buried in the ground or in plastic conduit: Type K soft-annealed.

2. Fittings: Solder type forged or wrought copper.
    a. Manufacturers: One of the following or equal:
        1) Hoke, Gyrolok.
        2) Crawford Fitting Co., Swagelok.
        3) Parker.
3. Solder: ASTM B32, Alloy Grade Sb5.
4. Flux: ASTM B813.
5. Grooved end fittings: ASME B16.22 wrought copper or ASME B16.18 bronze castings with copper tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted).
    a. Manufacturers:
        1) Victaulic Company.
6. Grooved mechanical couplings:
    a. “Installation Ready” stab-on coupling designed for direct ‘stab’ installation onto roll grooved copper tube without prior field disassembly and no loose parts.
    b. Housings shall be ductile iron, cast with offsetting, angle-pattern bolt pads coated with copper-colored enamel.
    c. Gasket shall be Grade “EHP” EPDM suitable for water temperatures up to 250 degrees Fahrenheit, and plated steel bolts and nuts.
    d. Victaulic Style 607 QuickVic™
7. Grooved joint flange adapters:
    a. ASTM A 536 ductile iron casting coated with copper-colored enamel, flat faced, designed for connecting directly to ANSI Class 125 and 150 flanged components.
    b. Victaulic Style 641.
8. Dielectric insulating unions or waterway fittings:
    a. Manufacturers: One of the following or equal:
        1) Mueller Co.
        2) Watts.
        3) Victaulic Co. Style 47.
9. Special thread to tube adapters:
    a. Manufacturers: One of the following or equal:
        1) Crawford Fitting Co., Swagelok.
        2) Hoke, Gyrolok.
        3) Parker.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
    1. Support copper piping and tubing as specified in Section 40_05_07.01 - Pipe Supports and Section 40_05_07.03 - Preformed Channel Pipe Support System.
    2. Clean copper lines with high-pressure air after first disconnecting piping at instruments, filters, pressure reducers, valve operators, and other special devices.
    3. Install copper pipe in accordance with IAPMO IS 3.

B. Installation of copper piping:
   1. Connect copper pipe connected to ferrous pipe or valves, or other non-copper items, by means of dielectric insulating unions or fittings.
   2. Where connections are made to meters or other devices having iron pipe size threaded fittings, provide special thread to tube adapters.
   3. Grooved joint piping systems shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations.
      a. Grooved couplings and fittings shall be the products of a single manufacturer.
      b. Grooving tools shall be of the same manufacturer as the grooved components.
      c. Gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
      d. Gaskets shall be molded and produced by Victaulic.
      e. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing.
      f. A Victaulic factory-trained field representative shall provide on-site training for Contractor's field personnel in the proper use of grooving tools and installation of grooved piping products.
      g. Factory-trained representative shall periodically review the product installation.
   4. Remove and replace any improperly installed products.

C. Installation of copper tubing:
   1. In accordance with ASTM B828 and IAPMO IS 3.
   2. Straight runs, supported at intervals close enough to avoid sagging.
   3. Make cuts square with a tubing cutter or with a 32-tooth hacksaw.
      a. Provide a sizing tool to correct distortions.
   4. Ream the inside of the tubing and remove burrs from the outside, holding the end of the tubing downward and preventing chips and fillings from entering the tubing.
   5. Perform flaring with a flare block and yoke type screw feed flaring tool:
      a. After removing the tubing from the flare block, inspect both surfaces of the flare for splits, cracks, or other imperfections.
      b. Where there are imperfections, cut off the imperfect flare, and prepare a new flare.

3.02 FIELD QUALITY CONTROL

A. Test copper lines in the same manner as the piping system to which they connect.

END OF SECTION

SECTION 40_05_19.01

DUCTILE IRON PIPE: AWWA C151

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ductile iron pipe, joints, connections, fittings, and pipe linings and coatings.

B. As specified in Section 40_05_00.01 - Common Work Results for General Piping.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

B. American Water Works Association (AWWA):
   1. C104 - Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   2. C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   3. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
   4. C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   5. C150 - Standard for Thickness Design of Ductile-Iron Pipe.
   6. C151 - Standard for Ductile-Iron Pipe, Centrifugally Cast.
   7. C210 - Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
   8. C222 - Polyurethane Coatings and Linings for Steel Water Pipe and Fittings.
   9. C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.
   10. C606 - Standard for Grooved and Shouldered Joints.

C. American Welding Society (AWS):
   1. D11.2 - Guide for Welding Iron Castings.

D. ASTM International (ASTM):
   1. A536 - Standard Specifications for Ductile Iron Castings.
   2. B1000 - Standard Practices for Casting Preparation and Test Procedure of Porcelain Enamel-Lined Pipe, Fittings, and Valves for Use in the Municipal Wastewater, Sewage, and Water Treatment Industry.
   3. C33 - Standard Specification for Concrete Aggregates.
   4. C150 - Standard Specification for Portland Cement.
   5. C283 - Standard Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
   6. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   7. D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

E. Ductile Iron Pipe Research Association (DIPRA):
   1. Thrust Restraint Design Manual.

F. International Organization for Standardization (ISO):
   1. 8179 - Ductile iron pipe, fittings, accessories and their joints - External zinc-based coating - Part 1: Metallic zinc with finishing layer.

G. National Association of Pipe Fabricators, Inc. (NAPF):
   1. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings.

H. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

I. Society for Protective Coatings (SSPC):
   1. SP 5 - White Metal Blast Cleaning.
   2. SP 10 - Near White Wet Blast.
   3. SP 11 - Bare Metal Power Tool Cleaning.
   4. PA 2 - Measurement of Dry Coating Thickness with Magnetic Gages.
   5. QP 1 - Industrial Contractor Qualification.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data.

C. Manufacturer's qualifications.
   1. Manufacturer qualifications and list of projects using the specified material: 5 years minimum.

D. Manufacturer's Quality Assurance Manual:
   1. Submit manufacturer's coating and lining application quality assurance manual to the Engineer prior to beginning coating application.
      a. Strict conformance to the requirements of the manual will be required.
      b. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.

E. Shop Drawings:
   1. Detailed layout drawings showing alignment of pipes, location of valves, fittings, and appurtenances, types of joints, and connections to pipelines or structures.
   2. Thrust restraint systems.
   3. Photographs, drawings, and descriptions of fittings, gaskets, couplings, grooving of pipe and fittings.

F. Calculations:
   1. Thrust restraint system design.

G. Manufacturer's Certificate of Source Testing for ceramic epoxy, glass lined, plural component polyurethane, and zinc materials:
   1. Certify successful performance of holiday detection tests on 100 percent of lining in accordance with ASTM B1000.
   2. Identify each test piece by mark designation and show the actual test results during the final inspection by the manufacturer prior to shipment.
   3. Zinc coating: Regular measurements in accordance with ISO 8179 Part 4.4.
   4. Include the coating manufacturer's technical representative's reports.

1.04 QUALITY ASSURANCE

A. Ductile iron pipe shall be supplied by a single manufacturer.

B. Hydrostatically test each joint of ductile iron pipe in accordance with AWWA C151.

C. Pre-installation meeting:
   1. Arrange for the coating manufacturer's technical representative to attend preconstruction conferences and to make periodic visits to the factory or shop to inspect surface preparation of pipe, fittings, and accessories; and to inspect application of linings to interior and coatings to exterior of pipe, fittings, and accessories.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Block piping and associated fittings for shipment to prevent damage to coatings and linings.

B. Carefully handle piping and associated fittings during loading, unloading, and installation:
   1. Do not drop piping material from cars or trucks.
   2. Lower piping by mechanical means.
   3. Do not drop or pound pipe to fit grade.

C. Handle pipe from the outside if lined with ceramic epoxy, glass or plural component polyurethane.
   1. No forks, chains, straps, hooks, or other lifting device shall be placed inside the pipe or fittings for lifting, positioning, or laying.

D. Protect gaskets and polyethylene encasement from long-term exposure to sunlight.

E. Store piping, fittings, and other accessories such that they do not accumulate and hold rainwater, dirt, and debris.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Ductile iron piping:
   1. Manufacturers: One of the following or equal:
      a. American Cast Iron Pipe Co.

b. McWane Ductile.
c. SIP Industries.
d. U.S. Pipe.

2.02 THRUST RESTRAINT SYSTEM DESIGN

A. Underground piping shall be fully restrained.

B. Length of pipe that must be restrained on each side of the focus of a thrust load as indicated in the Drawings.

C. Design pressure: As schedule in Pipe Schedule.

D. Laying condition: Type 5 in accordance with AWWA C150.

E. Soil type: Silt 1.

F. Unit friction resistance for polyethylene encasement of pipe: DIPRA factor multiplied by a safety factor of 1.5.

2.03 DUCTILE IRON JOINTS AND CONNECTIONS

A. General:
1. Pressure class or special thickness class as indicated in the Piping Schedule provided in Section 40_05_00.01 - Common Work Results for General Piping.
2. In accordance with AWWA C150 and AWWA C151.
3. Joints:
   a. Flanged.
   b. Grooved.
   c. Mechanical.
   d. Push-on rubber gasket.
   e. Integrally restrained mechanical.
   f. Mechanical wedge action.
   g. Integrally restrained push-on.
   h. Push-on joint restraint harness.
4. Connections:
   a. Tapping saddle.
   b. Tapping sleeve.
   c. Welded outlet.
5. Fittings.

B. Joints:
1. Flanged joints:
   a. Screw-on flanges:
      1) Comply with the diameter, thickness, drilling, and other characteristics in accordance with ASME B16.1.
      2) Ductile iron.
      3) Long hub, threaded, and specially designed for ductile iron pipe.
      4) After attaching to pipe, machine flange face to make pipe end and flange even and perpendicular to the axis of the pipe.
   b. Bolt holes on flanges: 2-holed and aligned at both ends of pipe.

c. Cap screw or stud bolt holes: Tapped.
d. Bolts and nuts:
    1) As specified in Section 40_05_00.01 - Common Work Results for General Piping.
e. Gaskets:
    1) Standard styrene butadiene copolymer (SBR) unless specified otherwise in Section 40_05_00.01 - Common Work Results for General Piping.

2. Grooved joints:
    a. In accordance with AWWA C606, as complemented and modified below, radius-cut type.
    b. Couplings:
        1) Rigid type, cast from ductile iron in accordance with ASTM A536, Grade 65-45-12.
    c. Bolts and nuts:
        1) As specified in Section 40_05_00.01 - Common Work Results for General Piping.
    d. Gaskets:
        1) As specified in Section 40_05_00.01 - Common Work Results for General Piping.
    e. Fittings:
        1) In accordance with AWWA C606, rigid radius-cut groove.
        2) Center-to-center dimensions: In accordance with AWWA C110.
        3) Wall thickness and other characteristics: In accordance with AWWA C606.
    f. Flanged unit connections:
        1) Flanged to grooved joint adapters or a long enough spool with one end flanged and the other end grooved to prevent interference with the operation of adjacent valves, pumps, or other items.
3. Mechanical joints:
    a. In accordance with AWWA C111.
    b. Gaskets:
        1) As specified in Section 40_05_00.01 - Common Work Results for General Piping.
    c. Bolts and nuts, including T-bolts:
        1) As specified in Section 40_05_00.01 - Common Work Results for General Piping.
4. Push-on rubber gasket joints:
    a. In accordance with AWWA C111.
    b. Gaskets:
        1) As specified in Section 40_05_00.01 - Common Work Results for General Piping.
5. Mechanical wedge action joint restraints:
    a. Manufacturers: One of the following or equal:
        1) EBAA Iron, Inc., Megalug® Series 1100.
        2) Sigma Corp., One-Lok Model SLDE.
        3) Star Pipe Products, Split Stargrip Series 3000.
    b. Materials:
        1) Gland body:
            a) Ductile iron in accordance with ASTM A536.

2) Wedges and wedge actuating components:
    a) Ductile iron in accordance with ASTM A536.
    b) Wedges shall be heat treated to a minimum of 370 BHN.
3) Actuating bolts and nuts:
    a) Ductile iron in accordance with ASTM A536.
    b) Provide torque-limiting twist off components to ensure proper installation.
4) Gaskets:
    a) As specified in Section 40_05_00.01 - Common Work Results for General Piping.

c. Coatings:
1) Provide manufacturer applied coating system.
2) Manufacturers: One of the following or equal:
    a) EBAA Iron Inc., Mega-Bond polyester powder applied by an electrostatic spray process.
    b) Sigma Corp., Corrsafe™ Electro-deposition coating.
    c) Star Pipe Products, Star-Bond™ TGIC polyester powder coating applied by an electrostatic spray process.

d. Working pressure:
1) Shall include a minimum safety factor of 2:1.
2) Sizes 3- through 16-inch: 350 pounds per square inch.
3) Sizes 18- through 48-inch: 250 pounds per square inch.

e. Restraint shall consist of multiple gripping wedges incorporated into a follower gland meeting the requirements of AWWA C111.

f. Restraint shall allow post assembly angular deflection that is a minimum of 50 percent of the angular deflection allowed by the mechanical joint.

g. Restraint must be in accordance with applicable requirements of AWWA C110 and AWWA C111 for mechanical joints.

6. Push-on joint restraint harnesses:
a. Manufacturers: One of the following or equal:
1) EBAA Iron, Inc., Megalug® Series 1700.
2) Sigma Corp., One-Lok Model SLDEH.
3) Star Pipe Products, Split Stargrip Series 3100S.

b. Materials:
1) Restraint and backup ring: Ductile iron in accordance with ASTM A536.
2) Wedges and wedge actuating components: Ductile iron in accordance with ASTM A536.
    a) Wedges shall be heat treated to a minimum of 370 BHN.
3) Actuating bolts and nuts:
    a) Ductile iron in accordance with ASTM A536.
    b) Provide torque-limiting twist off components to ensure proper installation.
4) Tie rods:
    a) Low alloy steel in accordance with AWWA C111.
5) Bolts and nuts, including T-bolts:
    a) As specified in Section 40_05_00.01 - Common Work Results for General Piping.

c. Coatings:
1) Provide manufacturer applied coating system.

2) Manufacturers: One of the following or equal:
a) EBAA Iron Inc., Mega-Bond polyester powder applied by an electrostatic spray process.
b) Sigma Corp., Corrsafe™ Electro-deposition coating.
c) Star Pipe Products, Star-Bond™ TGIC polyester powder coating applied by an electrostatic spray process.

d. Working pressure:
1) Shall include a minimum safety factor of 2:1.
2) For sizes 3- through 16-inch: 350 pounds per square inch.
3) For sizes 18- through 48-inch: 250 pounds per square inch.

e. Restraint shall consist of a backup ring behind the ductile iron bell and a restraint ring consisting of multiple gripping wedges connected with number and type of tie rods as recommended by the manufacturer.

f. Restraint shall allow post assembly deflection of a minimum of 50 percent of the deflection capability of the push-on joint.

C. Connections:
1. Tapping saddle as specified in Owner standard specification.
a. If Owner does not have a standard specification, provide tapping saddles as specified in Section 40_05_06.01 - Piping Specialties.
2. Tapping sleeve as specified in Owner standard specification.
a. If Owner does not have a standard specification, provide tapping sleeves as specified in Section 40_05_06.01 - Piping Specialties.
3. Welded outlet:
a. Not allowed without Engineer approval.

D. Fittings:
1. Ductile iron in accordance with AWWA C110 or AWWA C153.
2. Joint type:
a. Same as that of the associated piping as specified in Section 40_05_00.01 - Common Work Results for General Piping.
3. Plain end-to-flanged joint connectors using setscrews are not acceptable.

2.04 ASPHALT VARNISH

A. Coating for buried pipe:
1. Factory apply.

B. Primer:
1. Factory applied for field coating.

2.05 CEMENT MORTAR

A. Line pipe with cement mortar in accordance with AWWA C104 and as specified in this Section.

B. Cement:
1. Cement: In accordance with ASTM C150, Type II.

C. Water:
1. In accordance with AWWA C104 and as specified in this Section.

D. Sand and aggregate:
   1. In accordance with AWWA C104.
   2. Provide silica sand or other aggregate that is not subject to leaching in accordance with ASTM C33.

E. Lining:
   1. Minimum thickness: Standard in accordance with AWWA C104.
   2. Apply cement mortar on clean bare metal surfaces.
   3. Extend to faces of flanges, ends of spigots, and shoulders of hubs.
   4. Line special pieces or fittings by mechanical, pneumatic, or hand placement.
      a. Extend to faces of flanges and ends of spigots.
      b. Less than 12 inches in width: Coat with epoxy bonding agent prior to applying cement mortar.
      c. Larger than 12 inches in width: Reinforced with 2-inch by 4-inch No. 13 gauge welded steel wire mesh prior to applying cement mortar.
   5. Provide plastic end caps of sufficient thickness and strength to resist shipping, handling, and storage stresses.
   6. Repair damage to the cement mortar lining, including disbondment, or cracking caused by improper curing, shipping, handling, or installation in accordance with AWWA C104 and approved by the Engineer.
      a. Reinforce coating with 2 layers spirally-wound steel wire positioned approximately in center of mortar coating positioned approximately at the third points of mortar coating:
         1) No. 12 gauge spaced at maximum 1-inch centers.
         2) No. 14 gauge steel wire at maximum 1/2-inch centers.

2.06 GLASS LINING

A. Manufacturers: One of the following or equal, having a minimum of 5 years of experience supplying this product to the wastewater and water industry:
   1. Vitco Corp., SG-14 Lining.
   2. Water Works Manufacturing, Ferrock MEH-32 Lining.

B. Material:
   1. Special glasses and inorganic materials suited for lining of sewage, sludge, and scum piping.
   2. Thickness: 0.008 to 0.012 inch.
   3. Hardness: 5 to 6 on the Mohs Scale.
   4. Density: 2.5 to 3.0 grams per cubic centimeter, measured in accordance with ASTM D792.
   5. Thermal shock resistance: Capable of withstanding 350 degrees Fahrenheit change from 430 degrees Fahrenheit to 80 degrees Fahrenheit without crazing, blistering, or spalling.
   6. Gloss retention: Capable of retaining gloss after immersion in an 8 percent sulfuric acid solution at 148 degrees Fahrenheit for 10 minutes.
   7. Weight loss: Maximum 3 milligrams per square inch when tested in accordance with ASTM C283.

C. Fabrication:
   1. Use piping that is suitable for glass lining with minimum Class 53 wall thickness after application of glass lining.

2. Machine interior of pipe.
    a. Bore or grit blast in accordance with NAPF 500-03 prior to application of glass lining.
3. Screw factory assembled flanges on pipe, align boltholes, and flange faces, unless otherwise specified.
4. Apply lining to surfaces free of chemicals.
5. Place piping in furnaces specially designed for heating piping until glass melts and fuses with an integral molecular bond to the base metal.
6. Test 100 percent of the product in the factory in accordance with ASTM B1000.

2.07 POLYETHYLENE ENCASEMENT

A. General:
    1. Polyethylene encasement shall be supplied by the pipe manufacturer.

B. Materials: Supply one of the following polyethylene encasements:
    1. 2 layers of linear low-density polyethylene (LLDPE) film, minimum thickness of 8 mils in accordance with AWWA C105; or,
    2. Single layer of high-density, cross-laminated polyethylene (HDCLPE) film, minimum thickness of 4 mils in accordance with AWWA C105.
    3. Single layer of V-Bio® enhanced polyethylene encasement (3 layers of coextruded LLDPE film with anti-microbial additive and volatile corrosion inhibitor infused on the inside surface), meeting all requirements of AWWA C105.

2.08 SEAL COAT

A. Asphaltic seal coat:
    1. Apply over cement mortar linings and to outside surface of pipes that will not receive another coating.
    2. Apply in accordance with AWWA C151.

2.09 ZINC COATING

A. Zinc pipe coating:
    1. Exterior shall be coated with a layer of arc-sprayed zinc in accordance with ISO 8179.
    2. Mean mass of zinc based coating measured in accordance with ISO 8179 shall not be less than 200 grams per square meter of pipe surface area with a local minimum of 180 grams per square meter.
    3. Manufacturer shall carry out regular measurements of zinc coating masses in accordance with ISO 8179.
    4. Pipe markings shall include the word “zinc” or a similar designation clearly identifying the pipe has a zinc coating.
    5. Topcoat:
        a. Finishing layer shall be bituminous paint compatible with the zinc based layer. Mean dry film thickness shall be in accordance with AWWA C151.

B. Zinc fittings coatings:
   1. Exterior shall be coated with a zinc rich paint in accordance with ISO 8179. Dry film thickness shall be as recommended by the paint manufacturer, but not less than 2.0 mils.
   2. Fitting markings shall include the word “zinc”.
   3. Topcoat: Same as pipe coatings.

2.10 CORROSION MONITORING

A. As specified in Section 26_60_01 - Buried Galvanic Anode Cathodic Protection.

2.11 CATHODIC PROTECTION

A. As specified in Section 26_60_01 - Buried Galvanic Anode Cathodic Protection.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Install ductile iron piping in accordance with AWWA C600, or as modified in Section 40_05_00.01 - Common Work Results for General Piping.
   2. For underground piping, the trenching, backfill, and compaction:
      a. Inspect coating prior to backfill.
      b. As specified in Section 31_23_35 - Trenching.

B. Joints:
   1. Install types of joints as specified in the piping schedule provided in Section 40_05_00.01 - Common Work Results for General Piping.
   2. Mechanical joints are not acceptable in above ground applications.
   3. Field closure for restrained push-on pipe:
      a. Locate field closures in areas where thrust calculations demonstrate restraint is not required.
   4. Grooved joints:
      a. Install piping with grooved joints where specified in the piping schedule as specified in Section 40_05_00.01 - Common Work Results for General Piping.
      b. Assemble grooved joints in accordance with the manufacturer’s published instructions.
      c. Support grooved-end pipe in accordance with the manufacturer’s published instructions.
         1) Install at least 1 support between consecutive couplings.

C. Connection:
1. Tapping ductile iron pipe:
a. Direct tapping of ductile iron pipe may be performed but is limited to the following conditions:
1) Maximum allowable tap diameter by pipe diameter and pressure class:

Pipe Size (inches)	Pressure Class				
	150	200	250	300	350
	Maximum Allowable Direct Tap Size (inches)				
3	-	-	-	-	3/4
4	-	-	-	-	3/4
6	-	-	-	-	1
8	-	-	-	-	1
10	-	-	-	-	1
12	-	-	-	-	1-1/4
14	-	-	1-1/4	1-1/2	1-1/2
16	-	-	1-1/2	2	2
18	-	-	2	2	2
20	-	-	2	2	2
24	-	2	2	2	2

b. Maximum allowable tap diameter for pipelines greater than 24 inches is 2 inches.
c. 2 layers of 3-mil thread sealant are required to minimize the torque required to effect a watertight connection.
2. Direct tapping of glass lined ductile iron pipe may be performed only when approved in writing by the Engineer. Direct tapping of glass lined pipe shall be performed in accordance with the above conditions for tapping ductile iron pipe in addition to the following conditions:
a. Drilling and tapping shall be performed using a hole saw.
1) Use of a large drill bit is not acceptable.
b. As the hole saw approaches the glass lining, lessen the inward pressure to avoid excess chipping or cracking of the lining.
c. Minor chipping or spalling of the glass lining shall be repaired using an epoxy resin “glass repair kit” provided by the fabricator.
1) Manufacturers: One of the following or equal:
a) Devoe, Devran 224 HS.
b) Sherwin-Williams Co., Sher-Tile High Solids Epoxy.
2) Repair kit use is only allowed for areas of damage less than 1/2 inch in diameter.
a) Larger areas of damage will require replacement.
3) Surface shall be prepared and repair kit shall be applied in accordance with the manufacturer’s and/or fabricator’s instructions.
3. When direct tapping of ductile iron pipe is not possible due to limited wall thickness, a saddle tap shall be used.

3.02 DEFECTS IN COATINGS EXCEPT TAPE WRAP AND CEMENT MORTAR COATING

A. Engineer will identify defective coating to be field repaired in accordance with the applicable AWWA standard.
   1. Pipe joints exceeding the following defect maximum will be rejected.
      a. Minor defects:
         1) No more than 1.5 per 100 square feet of surface area.
         2) 2 or more minor repairs within an 8-inch diameter circle will be considered a single repair.
         3) Repairs for adhesion testing will not be included in the total number of repairs.
         4) Repair in accordance with the manufacturer's requirements.
      b. Major defects:
         1) No more than 3 major repairs on each pipe joint.
         2) No more than 30 percent repairs on the pipe surface area with defects.
   2. Minor repairs:
      a. Less than 8 inches in the greatest dimension.
      b. Repair in accordance with the manufacturer's requirements.
   3. Major repairs:
      a. Exceed 8 inches in the greatest dimension.
      b. Repair in accordance with the manufacturer's requirements.

3.03 POLYETHYLENE ENCASEMENT

A. Wrap buried ductile iron pipe and fittings in 2 layers of loose low-density polyethylene wrap or a single layer of high-density polyethylene wrap in accordance with AWWA C105 and as specified in this Section.

B. Wrap polyethylene encasement to be continuous and terminated neatly at connections to below grade equipment or structures.

C. At wall penetrations, extend encasement to the wall and neatly terminate.

D. At slab penetrations, extend encasement to 2 inches below the top of slab and neatly terminate.

E. When rising vertically in unimproved areas, extend encasement on pipe 6 inches above existing grade and neatly terminate.

F. Repair tears and make joints with 2 layers of plastic tape.

G. Work shall be inspected prior to backfilling of pipe and associated items.

3.04 CORROSION MONITORING FACILITIES

A. Bond pipe joints and associated fittings to provide electrical continuity.

B. Install dielectric insulating fittings and corrosion monitoring facilities as indicated on the Drawings and specified in Section 26_60_01 - Buried Galvanic Anode Cathodic Protection.

3.05 FIELD QUALITY CONTROL

A. Testing ductile iron piping:
   1. Test as specified in Section 40_05_00.01 - Common Work Results for General Piping and Section 40_05_00.09 - Piping Systems Testing.

B. Repair damaged cement mortar lining to match quality, thickness, and bonding of original lining in accordance with AWWA C104.
   1. When lining cannot be repaired or repairs are defective, replace defective piping with undamaged piping.

C. Verify that interior surfaces of ceramic epoxy and glass lined pipe and fittings have continuous coverage:
   1. Test random samples, as directed by the Engineer, in accordance with ASTM B1000.
   2. Discard lined piping and fittings found to have pinholes, crazing, or fish scales, which expose the metal substrate.

END OF SECTION

SECTION 40_05_23.01

STAINLESS STEEL PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Stainless steel piping and tubing.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.
   3. B16.11 - Forged Fittings, Socket-Welding and Threaded.
   4. B31.3 - Process Piping.
   5. B36.19 - Stainless Steel Pipe.

B. ASTM International (ASTM):
   1. A182 - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   2. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   3. A194 - Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High Pressure or High Temperature Service, or Both.
   4. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   5. A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   6. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   7. A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   8. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   9. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   10. A403 - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
   11. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   12. A744 - Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.

13. A774 - Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Services at Low and Moderate Temperatures.
14. A778 - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
15. A789 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service.
16. A790 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe.
17. A928 - Standard Specification for Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal.
18. A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
19. B622 - Standard Specification for Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube.
20. B912 - Standard Specification for Passivation of Stainless Steels Using Electropolishing.
21. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

C. American Welding Society (AWS):
   1. D1.6 - Structural Welding Code - Stainless Steel.

D. NSF International (NSF):
   1. Standard 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_00.01 - Common Work Results for General Piping.

C. Shop Drawings:
   1. Detailed layout drawings:
      a. Dimensions and alignment of pipes.
      b. Location of valves, fittings, and appurtenances.
      c. Location of field joints.
      d. Location of pipe hangars and supports.
      e. Connections to equipment and structures.
      f. Location and details of shop welds.
   2. Thickness and dimensions of fittings and gaskets.
   3. Photographs, drawings, and descriptions of pipe, fittings, welding procedures, and pickling and passivating procedures.
   4. Material specifications for pipe, gaskets, fittings, and couplings.
   5. Data on joint types and components used in the system including, flanged joints, grooved joint couplings and screwed joints.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Piping layout: Lay out and fabricate piping systems with piping sections as long as possible, while still allowing shipment, so that joints are minimized.
   1. Piping design indicated on the Drawings illustrates piping layout and configuration and does not indicate the location of every joint and flexible coupling that may be needed to connect piping sections fabricated in the shop.
   2. Where joints and couplings are specifically indicated on the Drawings, design and shop-fabricate piping sections utilizing the joint or coupling illustrated at the locations shown.
   3. Add joints and flexible couplings in a manner that achieves intent of maximizing size of individual piping sections.

B. Shop fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture.

C. Field assembly:
   1. Field welding is prohibited.

2.02 STAINLESS STEEL PIPE

A. General:
   1. Pipe sizes specified in the Specifications and indicated on the Drawings are nominal.

B. Wall thickness:
   1. As specified in Section 40_05_00.01 - Common Work Results for General Piping.

C. Piping material and manufacturing:
   1. Comply with the requirements outlined in the following table:

Service	Stainless Steel Grade	Pipe Manufacturing Process
For low chloride water service with chloride concentrates below 200 parts per million and/or free chlorine less than 2 parts per million at ambient temperatures.		
Piping 3 inches in nominal diameter and larger	Type 304L stainless steel in accordance with ASTM A240	In accordance with ASTM A778
Piping less than 3 inches in nominal diameter	Type 304L stainless steel in accordance with ASTM A240	In accordance with ASTM A312
Digester Gas, Oxygen and Ozone Service, Membrane and Reverse Osmosis Filtration Systems with chloride concentrations less than 1,000 parts per million and/or free chlorine less than 4 parts per million at ambient temperatures.		
Piping 3 inches in nominal diameter and larger	Type 316L or LDX 2101 stainless steel in accordance with ASTM A240	Type 316L in accordance with ASTM A778
		Type LDX 2101 in accordance with ASTM A790

Service	Stainless Steel Grade	Pipe Manufacturing Process
Piping less than 3 inches in nominal diameter	Type 316L or LDX 2101 stainless steel in accordance with ASTM A240	Type 316L in accordance with ASTM A312
		Type LDX 2101 in accordance with ASTM A790
Brackish water Membrane and Reverse Osmosis Membrane Filtration Systems with chloride concentrations between 1,000 and 10,000 parts per million.		
All piping diameters	Austenitic or duplex grades of material with PREN greater than 33	In accordance with ASTM A312, ASTM A778, ASTM A790, or ASTM A928
Brackish and Seawater Membrane and Reverse Osmosis Membrane Filtration Systems with chloride concentrations between 10,000 to 20,000 parts per million		
All piping diameters	Austenitic and duplex grades of material with PREN greater than 40	In accordance with ASTM A312, ASTM A790 or ASTM A928
Brackish and Seawater Reverse Osmosis Concentrate (i.e., Brine) with chloride concentrations greater than 20,000 parts per million		
All piping diameters	Austenitic and duplex grades of material with PREN greater than 45	In accordance with ASTM A312, ASTM A778, ASTM A790, or ASTM A928
PREN: Pitting Resistance Equivalency Number. PREN = Cr% + (3.3 x Mo%) + (16 x N%).		

UNS #	Alloy	Cr%	Mo%	N%	Other	PREN
N10276	C-276	14.5-16	15-17	-	W 3-4.5	64
S32750	Alloy 2507	24-26	6-8	0.24-0.32	-	48
S32654	654SMO	24-25	7-8	-	-	47
N06625	Alloy 625	20-23	8-10	-	Cb 3.25-4.15	46
N08366	AL6XN	20-22	6-7	-	-	40
N06985	Alloy G	21-23.5	5.5-7.5	-	-	39
S32760	Zeron 100	24-26	3-4	0.2-0.3	W 0.5-1.0	37
S32205	Alloy 2205	22-23	3-3.5	0.14-0.20	-	34
N08904	904L	19-23	4-5	-	-	32
S31726	317LNM	17-20	4-5	0.1-0.2	-	32
N08825	Alloy 825	19-23.5	2.5-3.5	-	-	27
S32101	LDX-2101	21.5	0.3	0.22	-	26
S31603	316L	16-18	2-3	-	-	23
S30403	304L	18-20	-	-	-	18

D. Fittings for piping 3 inches in nominal diameter and greater:
   1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.
   2. Manufacturing standard: In accordance with ASTM A774.
   3. Wall thickness of fitting: In accordance with ASME B36.19 for the schedule of pipe specified.
   4. End configuration: As needed to comply with specified type of joint.
   5. Dimensional standards:
      a. Fittings with weld ends: In accordance with ASME B16.11.
      b. Fittings with flanged ends: In accordance with ASME B16.5, Class 150.

E. Fittings for piping less than 3 inches in diameter:
   1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.
   2. Manufacturing standard: In accordance with ASTM A403, Class WP.
   3. Wall thickness and dimensions of fitting: In accordance with ASME B16.11 and as required for the schedule of pipe specified.
   4. End configuration: As needed to comply with specified type of joint.
   5. Forgings in accordance with ASTM A182, or barstock in accordance with ASTM A276. Match forging or barstock material to the piping materials.

F. Piping joints:
   1. Joint types, piping greater than 2 inches in diameter, general:
      a. Where type of joint is specifically indicated on the Drawings or specified, design and shop-fabricate piping sections utilizing type of joint illustrated or scheduled.
      b. Joints at valves and pipe appurtenances:
         1) Provide flanged valves and flanged pipe appurtenances in stainless steel piping systems with flanged ends.
         2) Design and fabricate piping sections to make connections with flanged valves and pipe appurtenances using flanged coupling adapters or flanged joints.
            a) Flexible couplings and flanged coupling adapters: Provide stainless steel construction with materials matching the piping system and in accordance with requirements as specified in Section 40_05_06.03 - Pipe Couplings.
   2. Joints in piping 2 inches in diameter and smaller: Flanged, grooved, welded, press fit, or screwed with Teflon™ tape thread lubricant, as specified in Section 40_05_00.01 - Common Work Results for General Piping.
   3. Welded joints:
      a. Piping 12 inches and larger in diameter: Automatically weld joints using gas tungsten-arc procedures.
      b. Piping 4 inches through 12 inches in diameter: Double butt welded joints.
      c. Piping less than 4 inches in diameter: Single butt-welded joints.
      d. Mark each weld with a symbol that identifies the welder.
   4. Flanged joints: Conforming to the requirements in accordance with ASME B16.5, Class 150.
   5. Flanges for Schedule 40S and Schedule 80S pipe:
      a. Provide forged stainless steel (type matching piping system) welding neck flanges or slip-on flanges in accordance with ASME B16.5 Class 150.
      b. Material: In accordance with ASTM A182.

6. Grooved joints:
    a. Pressure less than 500 pounds per square inch:
        1) Cut grooves from Schedule 40 or higher.
    b. Heavier schedule pipe sections used for cut groove ends:
        1) Tapered inside diameter to transition from the inside diameter of the lighter schedule pipe.
    c. Butt welds connecting pipes of different schedules that leave an abrupt change in inside diameter are not allowed.
    d. Couplings:
        1) Rigid type, cast from ductile iron, Victaulic Style 07 or equal. High performance coating as specified in Section 09_96_01 - High-Performance Coatings.
7. Press fit joints:
    a. Pressures less than 500 pounds per square inch:
        1) Fittings:
            a) Victaulic Vic-Press™ 316, ASTM A312 stainless steel housings with ASTM A276 and ASTM A312 outlets and stainless steel plain or grooved ends, Type 316 stainless steel.
            b) Flange adaptors:
                (1) ANSI Class 150, Van Stone type with stainless steel backup flange and Vic-Press™ ends.
                (2) Rated for service up to 275 pounds per square inch gauge. Victaulic Style P566.
            c) Threaded unions shall be Victaulic Style P585, Type 316 stainless steel, with Vic-Press™ ends.
        2) Gaskets:
            a) Gaskets shall be Grade E EPDM rated for services up to 250 degrees Fahrenheit.
        3) Valves:
            a) Provide Victaulic Series P569 stainless steel ball valves with PTFE seats and Vic-Press™ and/or grooved ends.
            b) Rated for services to 400 pounds per square inch (2,750 kilopascals).
            c) Swing-out design to facilitate in-line maintenance: 3-piece.

G. Gaskets:
1. Ozone and oxygen service: TFE sheet.
2. Aeration air service: As specified in Section 40_05_00.01 - Common Work Results for General Piping.
3. All other service applications: EPDM, nitrile, or other materials compatible with the process fluid.
    a. Drinking water applications: NSF Standard 61 compliant materials only.

H. Bolts for flanges:
1. Bolts and nuts: Type 316 stainless steel in accordance with ASTM A193 heavy hex head.
    a. Bolt length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut.
    b. Nuts: In accordance with ASTM A194 heavy hex pattern.

I. Fabrication of pipe sections:
   1. Welding: Weld in accordance with ASME B31.3.
   2. Weld seams:
      a. Full penetration welds, free of oxidation, crevices, pits and cracks, and without undercuts.
      b. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.
      c. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.
      d. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

J. Cleaning (pickling) and passivation:
   1. Following shop fabrication of pipe sections, straight spools, fittings, and other piping components, clean (pickle) and passivate fabricated pieces.
   2. Clean (pickle) and passivate in accordance with ASTM A380 or ASTM A967.
      a. If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible.
         1) However, these treatments must be followed by inorganic cleaners such as nitric acid/hydrofluoric acid.
      b. Passivation treatments with citric acid are not allowed.
   3. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.

2.03 STAINLESS STEEL TUBING

A. Stainless steel tubing:
   1. Seamless tubing made of Type 316L stainless steel and in accordance with ASTM A269, wall thickness not less than 0.035 inch.

B. Fittings: Swage ferrule design:
   1. Components made of:
      a. Type 316 stainless steel.
   2. Double acting ferrule design, providing both a primary seal and a secondary bearing force.
   3. Flare type fittings are not acceptable.
   4. Manufacturers: One of the following, or equal:
      a. Crawford Fitting Co., Swagelok.
      b. Hoke, Gyrolok.
      c. Parker, CPI.

C. Valves for use with stainless steel tubing:
   1. Ball type valves with swage ends to match tubing diameter.
   2. Constructed from:
      a. Type 316 stainless steel with TFE seats.
   3. Manufacturers: The following or equal:
      a. Crawford Fitting Co., Swagelok.

2.04 SOURCE QUALITY CONTROL

A. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

B. Provide written certification that the pipe as supplied are in accordance with ASTM A778. Supplemental testing is not required.

C. Provide written certification that the fittings as supplied are in accordance with ASTM A774.
   1. Supplementary testing is not required.

D. Thoroughly clean any equipment before use in cleaning or fabrication of stainless steel.

E. Storage: Segregate location of stainless steel piping from fabrication of any other piping materials.

F. Shipment to site:
   1. Protect flanges and pipe ends by encapsulating in dense foam.
   2. Securely strap all elements to pallets with nylon straps. Use of metallic straps is prohibited.
   3. Cap ends of tube, piping, pipe spools, fittings, and valves with non-metallic plugs.
   4. Load pallets so no tube, piping, pipe spools, fittings, or valves bear the weight of pallets above.
   5. Notify Engineer when deliveries arrive so Engineer may inspect the shipping conditions.
   6. Engineer may reject material due to improper shipping methods or damage during shipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install piping in such a manner as not to impart strain to connected equipment.

B. Install Victaulic Vic-Press™ joint systems in accordance with the manufacturer's latest recommendations. Follow the instructions listed in the latest Victaulic I-P500 assembly manual.
   1. Pipe shall be square cut, plus or minus 0.030 inches, properly deburred and cleaned.
   2. Pipe ends shall be marked at the required location, using a manufacturer-supplied gauge, to ensure full insertion into the coupling or fitting during assembly.
      a. Use a Victaulic PFT-510 series tool with the proper sized jaw for pressing joints.
      b. Tool shall be fitted with the proper size Victaulic jaw for pressing.

C. Slope horizontal lines so that they can be drained completely.

D. Provide valve drains at low points in piping systems.

E. Install eccentric reducers where necessary to facilitate draining of piping system.

F. Provide access for inspection and flushing of piping systems to remove sediment, deposits, and debris.

3.02 FIELD ASSEMBLY OF SHOP-FABRICATED PIPING SECTIONS

A. Join shop-fabricated piping sections together using backing flanges, flexible couplings, flanged coupling adapters, grooved couplings, or flanges.

3.03 FIELD QUALITY CONTROL

A. Test piping to pressure and by method as specified in Section 40_05_00.01 - Common Work Results for General Piping.
   1. If pressure testing is accomplished with water:
      a. Use only potable quality water.
      b. Piping: Thoroughly drained and dried or place immediately into service.

B. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

3.04 PROTECTION

A. Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the Work.
   1. Use handling methods and equipment to prevent damage to the coating, include the use of wide canvas slings and wide padded skids.
   2. Do not use bare cables, chains, hooks, metal bars, or narrow skids.
   3. Store stainless steel piping and fittings away from any other piping or metals. Storage in contact with ground or outside without projection from bad weather is prohibited.
   4. Protect stainless steel piping and fittings from carbon steel projections (when grinding carbon steel assemblies in proximity) and carbon steel contamination (do not contact stainless steel with carbon steel wire brush or other carbon steel tool).

END OF SECTION

SECTION 40_05_24.01

STEEL PIPE: EXPOSED

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel piping, joints, fittings, fabricated steel piping fittings and specials, and plural component polyurethane lining.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.3 - Malleable-Iron Threaded Fittings: Classes 150 and 300.
   3. B16.5 - Pipe Flanges and Flanged Fittings.
   4. B16.9 - Factory-Made Wrought Buttwelding Fittings.
   5. B16.12 - Cast Iron Threaded Drainage Fittings.

C. American Water Works Association (AWWA):
   1. C200 - Steel Water Pipe 6 Inches and Larger.
   2. C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe: 4 inches and Larger-Shop Applied.
   3. C206 - Field Welding of Steel Water Pipe.
   4. C207 - Standard for Steel Pipe Flanges for Waterworks Service-Sizes 4 inches Through 144 inches.
   5. C208 - Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   6. C210 - Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
   7. C222 - Polyurethane Coatings and Linings for Steel Water Pipe and Fittings.
   8. C606 - Standard for Grooved and Shouldered Joints.
   9. M11 - Steel Pipe: A Guide for Design and Installation.

D. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Casting.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
   4. A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   5. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   6. A536 - Standard Specification for Ductile Iron Castings.
   7. C33 - Standard Specification for Concrete Aggregates.

8. C150 - Standard Specification for Portland Cement.
9. C205 - Standard Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements.
10. D297 - Standard Test Methods for Rubber Products-Chemical Analysis.
11. D395 - Standard Test Methods for Rubber Property-Compression Set.
12. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
13. D471 - Standard Test Methods for Rubber Property-Effect of Liquids.
14. D573 - Standard Test Methods for Rubber -Deterioration in an Air Oven.
15. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
16. D2240 - Standard Test Method for Rubber Property-Durometer Hardness.
17. D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
18. E165 - Standard Practice for Liquid Penetrant Testing for General Industry.

E. NACE International (NACE):
1. SP0188 - Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.

F. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.

G. Society for Protective Coatings (SSPC):
1. SP 5 - White Metal Blast Cleaning.
2. SP 10 - Near White Wet Blast.
3. SP 11 - Bare Metal Power Tool Cleaning.
4. QP 1 - Industrial Contractor Qualification.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_00.01 - Common Work Results for General Piping.

C. Manufacturer's qualifications.
1. Manufacturer qualifications and list of projects using the specified material: 5 years minimum.

D. Manufacturer's Quality Assurance Manual:
1. Submit manufacturer's coating and lining application quality assurance manual to Engineer prior to beginning coating application.
   a. Strict conformance to the requirements of the manual will be required.
   b. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.

E. Shop drawings:
1. Details of fittings and specials showing thickness and dimensions of plates.
2. Details of welds and materials.
3. Listing of proposed services and locations for use of grooved joint type piping.

4. Tabulated layout schedules for cement-mortar lined and coated steel pipe.
5. Grooved joint piping fittings, gaskets, and couplings.
6. Grooving of pipe and fittings.

F. Calculations:
1. Submit calculations prepared and stamped by a professional engineer licensed in the State of Washington. The calculations shall be based on the requirements defined in this Section.
2. Design calculations: Wall thicknesses for external loading, special loading, internal pressure, and other necessary design cases.

G. Certificates of Compliance: Cement-mortar lined and coated steel pipe.

H. Mill certificates.

I. Test reports: Rubber gaskets.

1.04 QUALITY ASSURANCE

A. Applicable standards:
1. Steel pipe larger than 12 inches diameter shall conform to the following standards, as complemented and modified in this Section:
a. Steel pipe: AWWA C200.
b. Fittings and specials: AWWA C208.
c. Reinforcement of fittings and specials: AWWA M11.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
1. Design criteria for pipe and pipe fittings: In accordance with AWWA M11 with the following modifications:
a. Wall thickness: Thicker of the thickness specified in Section 40_05_00.01 - Common Work Results for General Piping Pipe Schedule, and the following thickness:
1) For pipes smaller than 26 inches in diameter: Minimum 1/4 inch.
2) For pipes 26 inches and larger but less than 38 inches in diameter: Minimum 5/16 inch.
3) For pipes 38 inches and larger in diameter and including 72 inches in diameter: Minimum 3/8 inch.
b. Inside diameter of unlined pipe: Nominal.
c. Inside diameter of lined pipe: As measured from face to face of liner, but not less than nominal.
d. Working stress of steel: Maximum 50 percent of yield stress.
e. Contractor shall develop and submit calculations to determine the steel pipe and fitting wall thickness and design requirements according to the requirements of this specification.

2.02 MATERIALS

A. Steel pipe:
   1. Type, pipe 6 inches and smaller: ASTM A53, black or galvanized, seamless or straight seam electric resistance welded. Minimum Schedule 40.
   2. Type, from 6 to 12 inches: ASTM A53, black or galvanized pipe, seamless or straight seam electric resistance welded. Minimum Schedule 20.
   3. Type, larger than 12 inches: AWWA C200, without butt strap, riveted, or swaged joints; wall thickness as specified.
   4. Type, 24 inches and larger, with grooved type couplings and wall thickness less than 1/2-inch: Provided with stub ends, sized as follows, for grooves.
      a. Thickness: As recommended by coupling manufacturer, but not less than 1/2-inch.
      b. Length: Width of coupling plus 1 inch, but not less than 6 inches.

B. Steel pipe fittings:
   1. Screwed fittings:
      a. Malleable iron: ASME B16.3, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe.
      b. Cast iron drainage: ASME B16.12, galvanized in accordance with ASTM A153 where used with galvanized pipe.
   2. Flanged fittings:
      a. Type for 12-inch and smaller pipe: ASME B16.1, cast iron or ductile iron, 125 pounds; or ASME B16.5, steel, 150 pounds, galvanized in accordance with ASTM A153 where used with galvanized pipe.
      b. Type for larger than 12-inch pipe: ASME B16.5, steel, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe; or AWWA C207 and AWWA C208, fabricated from flanges and steel pipe, respectively.
      c. Companion flanges for 4 inches and smaller pipe: ASME B16.1, cast iron or ductile iron, 125 pounds; ASME B16.5, steel, 150 pounds, slip-on or welding neck; or ammonia type for use on chlorine liquid or gas piping.
      d. Companion flanges for larger than 4 inch to and including 12-inch pipe: ASME B16.5, slip-on or welding neck type.
      e. Companion flanges for larger than 12-inch pipe: ASME B16.5, steel, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe; or AWWA C207, steel plate or raised hub type.
      f. Weld flanges to pipe or fittings before applying lining.
      g. Machine flanges or provide tapered filler for changes in grade or to slope lines for drainage.
      h. Flange bolts: As specified in Section 40_05_00.01 - Common Work Results for General Piping.
      i. Gaskets: As specified in Section 40_05_00.01 - Common Work Results for General Piping.
   3. Welding fittings:
      a. Welding fittings for piping 8 inches and less in nominal diameter: Butt-welding fittings in accordance with ASME B16.9, standard wall, or standard weight.
      b. Welding fittings for piping larger than 8 inches in nominal diameter: Butt-welding fittings in accordance with ASME B16.9, or, at the option of the

Contractor, made up out of sections of pipe welded together, except where smooth bends are indicated for air lines.

c. Fittings made up of sections of pipe welded together shall be made of pipe of at least the same wall thickness as the pipe with which used, and bends shall be miter bends, fabricated in accordance with AWWA C208 and as supplemented by AWWA M11. Welding of these made-up fittings shall be in accordance with AWWA C206.
    1) Design and fabricate outlets and 4 branch fittings in accordance with AWWA M11.
    2) Bends may be welded to adjacent pipe sections.
        a) Bends shall be manufactured of the following number of pieces:
            (1) Bends from 0 to 30 degrees angle, 2 pieces.
            (2) Bends from 30 to 45 degrees angle, 3 pieces.
            (3) Bends from 45 to 67-1/2 degrees angle, 4 pieces.
            (4) Bends from 67-1/2 to 90 degrees angle, 5 pieces.

4. Grooved joint fittings:
    a. Fittings for grooved joint steel piping: Rigid-grooved type, and as follows:
        1) Grooves: Cut; rolled grooves are not acceptable.
        2) Couplings: Cast in 2 or more segments of ductile iron in accordance with ASTM A536, Grade 65-45-12 or malleable iron in accordance with ASTM A47, Grade 32510.
        3) Bolts and nuts: As specified in Section 40_05_00.01 - Common Work Results for General Piping.
        4) Gaskets: Composition water sealing designed so that the internal piping pressure serves to increase the seal's watertightness.
            a) Gaskets for water service and oil-free air systems at temperatures less than 230 degrees Fahrenheit shall be made of ethylene propylene diene monomers (EPDM) in accordance with ASTM D2000 Line Call Out 2CA615A25B24.
            b) Gaskets for use with cement-mortar lined steel piping shall be captured between the ends of the pipe to protect exposed metal from corrosion, and shall be made of nitrile in accordance with ASTM D2000, Line Call Out 2CA615A25B24.
        5) Perform grooving of the pipe wall only on standard or heavier schedule weight pipe.
            a) For pipe with wall thickness less than standard weight, weld a shouldered end on the pipe in accordance with AWWA C606.
            b) Fabricated pipe, pipe in accordance with AWWA C200, shall have shouldered ends welded onto the pipe.
            c) Shoulder: Type B or D in accordance with AWWA C606.
        6) Couplings and grooving:
            a) Manufacturers: One of the following or equal:
                (1) Gustin-Bacon Piping Products.
                (2) Victaulic Co.
    b. Fittings for grooved joint piping: Ductile iron in accordance with ASTM A536, Grade 65-45-12, or malleable iron in accordance with ASTM A47, Grade 32510, and as follows:
        1) Where cast fittings are not made, standard fittings including large diameter elbows shall be made of forged steel in accordance with ASTM A105, Grade B with 0.375 inch wall thickness, or shall be

standard segmentally welded fittings fabricated of Schedule 40 carbon steel pipe.

a) Grooves:

(1) Manufacturers: One of the following or equal:

(a) Gustin-Bacon Piping Products.

(b) Victaulic Co.

2) Fittings for grooved joint piping shall be furnished by the manufacturer of the grooved joint material.

3) Fittings for grooved joint piping shall be for rigid-grooved type joints.

4) Connection to flanged units shall be by means of flange to grooved joint adapters.

a) Where the flanged to grooved joint adapters interfere with the operation of adjacent valves, pumps, or other items, the connection shall be by means of a spool with one end flanged and the other grooved, long enough to prevent interference with adjacent valves, pumps, or other items.

C. Steel pipe lining and coating.

1. General:

a. Except where otherwise specified in the Specifications or indicated on the Drawings, lining and coating for steel pipe shall be as specified in Section 40_05_00.01 - Common Work Results for General Piping.

D. Fabricated steel piping fittings and specials:

1. General: Specified in this Section are the design and fabrication of fabricated steel piping fittings and specials, which include elbows, branches, nozzles, manifolds, headers, heads, collars, stiffeners, reinforcements, and other steel fabrications relating to steel piping, but shall not include steel pipe.

2. Design:

a. Contractor shall design and detail fittings and specials.

1) Design: In accordance with the recommended procedures in AWWA Manual M11, as complemented and modified in this Section.

2) Nozzles: Reinforced in accordance with recommended practice in AWWA M11, Steel Pipe Manual.

3) Design reinforcing for fittings and specials for the specified test pressure.

4) Fittings shall conform in dimension to AWWA C208, complemented with the provisions specified in this Section.

5) The working stress for steel used for fabrication of pipe shall not exceed 50 percent of the yield stress.

b. The thickness of pipe, large elbows, and headers, except header nozzles, shall be the thicker of:

1) The thickness designed in accordance with the design methods specified in this Section.

2) The thickness as specified in Section 40_05_00.01 - Common Work Results for General Piping Pipe Schedule, or as required by the Contractor’s calculations.

3) The following thicknesses:

a) For pipes smaller than 26 inches in diameter: Minimum 1/4 inch.

b) For pipes 26 inches and larger but less than 38 inches in diameter: Minimum 5/16 inch.
c) For pipes 38 inches and larger in diameter and including 72 inches in diameter: Minimum 3/8 inch.

c. Elbows shall be of the number of pieces as specified in this Section, and thickness of material shall conform to thickness of pipe or manifold shells specified.
d. Ends of fittings to be welded to pipe shall be beveled for welding.

3. Fabrication:
   a. Shop fabricate steel piping fittings and specials in units as long as practicable for safe hauling and installation. Minimize number of field welds.
   b. Fabricate fittings and specials to uniform lengths with proper end clearance for the specified types of joint or attachment.
   c. Fabricate fittings and specials to allow field assembly without cutting or special work.
   d. Do not weld flanges to nozzles until the nozzles and reinforcements are completely welded to the header.
      1) Accurately space and align flanges so that when connections have been made there will be no stress on the header, piping, or equipment. Properly locate and align equipment.
4. Dished heads:
   a. Dished heads on 84 inch diameter and smaller manifolds: 1 piece (seamless) spherically dished (torispherical) heads.
      1) Larger heads may be seamed.
   b. Dish radius: Same dimension as the outside diameter of the head measured at skirt.
   c. Skirt face length: Not less than 3 inches.
   d. Design heads in accordance with recommended practice in AWWA M11, Steel Pipe Manual.
5. Testing: No shop testing will be required for manifolds or piping connected thereto.

E. AWWA C200 steel pipe and fittings design and fabrication:
1. General:
   a. Applicable standards: AWWA C200 steel pipe shall conform to the standards specified in General of this Section.
   b. Identification marks: Provide identification marks in accordance with AWWA C200. These marks shall be stenciled or otherwise shown at the top of the piping items exterior, including the following information:
      1) Name or trademark of the manufacturer.
      2) Date of manufacture of the item.
      3) Internal diameter in inches.
      4) Number of the item, sequential from initial to end station.
   c. Diameter designation: The pipe diameter specified in the Specifications and indicated on the Drawings shall be the clear inside diameter after application of the cement-mortar lining with a tolerance of plus 0 inch and minus 1/4 inch.
2. Design:
   a. Pipe and fittings shall be designed by Contractor.

b. Design: In accordance with the recommended procedures in AWWA Manual M11, as complemented and modified in this Section.
c. Thicknesses of pipe, fittings and specials shall be the thicker of:
    1) The thickness designed in accordance with the design methods specified in this Section.
    2) The thickness indicated on the Drawings or specified in Section 40_05_00.01 - Common Work Results for General Piping Pipe Schedule.
    3) The following thicknesses:
        a) For pipes smaller than 26 inches in diameter: Minimum 1/4 inch.
        b) For pipes 26 inches and larger but less than 38 inches in diameter: Minimum 5/16 inch.
        c) For pipes 38 inches and larger in diameter and including 72 inches in diameter: Minimum 3/8 inch.
d. The working stress for steel used for fabrication of pipe shall not exceed 50 percent of the yield stress.
e. Break longitudinal and girth seams for straight seam pipe shall be no greater in number than would be required for the fabrication of pipe with 96-inch by 120-inch steel plates.
    1) Break longitudinal seams at the girth seams.
f. Where piping is designated to be flanged or welded in order to restrain thrust, the design of the cylinder and flange or welded joint shall take into account the effect of stresses caused by thrust loads.

3. Materials:
    a. Coatings and linings: As required in Section 40_05_00.01 - Common Work Results for General Piping.
    b. Gaskets shall be as specified in Section 40_05_00.01 - Common Work Results for General Piping and meet the following requirements:
        1) Minimum tensile strength, tested in accordance with ASTM D412, between 2,000 and 2,700 pounds per square inch.
        2) Minimum elongation, tested in accordance with ASTM D412, between 350 and 400 percent.
        3) Shore A durometer hardness, tested in accordance with ASTM D2240, between 50 and 65.
        4) Specific gravity, tested in accordance with ASTM D297, between 0.90 and 1.50.
        5) Maximum compression set, tested in accordance with Method B of ASTM D395, 20 percent.
        6) Maximum tension strength loss, tested in accordance with ASTM D573 at 96 hours, 70 degrees Centigrade, in air, 20 percent.
        7) Maximum elongation loss, tested in accordance with ASTM D573 at 96 hours, 70 degrees Centigrade, in air, 20 percent.
        8) Maximum absorption, tested in accordance with ASTM D471 at 48 hours, 70 degrees Centigrade, in air, 5 percent.
4. Joints and connections:
    a. Joints:
        1) Except as otherwise specified or indicated on the Drawings, provide lap welded or bell and spigot type joints with rubber gaskets for pipelines 54 inches and smaller.

2) Butt-strap joints shall be used only where required for closures or where indicated on the Drawings.
3) The joints furnished shall have the same or higher-pressure rating as the abutting pipe.

b. Connections:
1) Connections to existing systems shall be made using a flange isolation joint.
2) If an existing pipeline or facility does not include a flange at or near the connection point:
a) An isolation flange shall be placed in the first length of pipe.
b) A butt-strap joint shall be used to connect the first length of pipe to the existing pipeline.

c. Bell and spigot joint rings: Rolled Carnegie shape M-3516.

d. Lap welded joints:
1) Double fillet weld lap welded joints shall be welded on the inside and outside of the joint.
2) Lap joints prepared for electric field welding shall be in accordance with AWWA C206.
3) Joint forming:
a) Joint geometry and joint field weld will be such that no part of any field weld will be closer than 1 inch to the nearest point of tangency to the bell radius.
b) Bell ends shall be formed by and expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape.
4) Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.

e. Butt-strap joints: Butt-strap joints where used or required, shall be:
1) A minimum of 10 inches wide.
2) The same thickness as the pipe wall.
3) Provide for a minimum of 2-inch lap at each pipe joint.
4) Double fillet weld each side of joint on the inside and outside of the joint.

f. Flanges: AWWA C207, Class D, steel ring, and as follows:
1) Match pipe flanges to the valve flanges:
a) At flanged joints connecting to valves, provide a steel pipe section without rod reinforcing and not less than 24 inches in length.
b) Apply cement-mortar lining and coating to the steel pipe section.
2) Flange bolts: As specified in Section 40_05_00.01 - Common Work Results for General Piping.
3) Gaskets: As specified in Section 40_05_00.01 - Common Work Results for General Piping.

5. Fabrication:
a. Shop coat of primer: Flanges and portions of pipe not covered with cement-mortar shall be given a shop coating of primer.
b. Bend radii of fittings: Not less than 2.5 times the nominal diameter in accordance with AWWA C208.

2.03 COATING AND LINING - GENERAL

A. Coating and lining shall be as specified in Section 40_05_00.01 - Common Work Results for General Piping.

B. Extend pipe coatings for underground piping 6-inches above finished grade or 3-inches above finished floor, and neatly terminate.

C. As specified in Section 01_60_00 - Product Requirements.

D. Prepare, install, and repair in accordance with manufacturer's requirements.

E. Contractor is responsible for:
   1. That coating selected is suitable for the application conditions anticipated, such as temperature, humidity, etc.
   2. Managing the project schedule to allow adequate cure time before backfill or immersion based on surface temperatures at the time of application.

2.04 PLURAL COMPONENT POLYURETHANE

A. Where indicated in Section 40_05_00.01 - Common Work Results for General Piping, line pipe with plural component, polyurethane coating system applied in accordance with AWWA C222 and as specified in this Section.

B. Manufacturers: One of the following or equal:
   1. Lifelast, Durashield 310.
   2. Chemline, Chemthane 2265.

C. Total minimum Dry Film Thickness (DFT): 80 mils.

D. Surface preparation:
   1. In accordance with AWWA C222 and as specified in this Section.
   2. In accordance with SSPC-SP 5, 3.00 mil profile, minimum, or in accordance with manufacturer’s requirements, whichever is greater.

E. Adhesion test procedures:
   1. Use self-aligning pneumatic pull off equipment and test procedures in accordance with ASTM D4541, Method E, using Delfesko Positest AT-A except as modified in this Section.
      a. Perform at an applied load rate of 100 pounds per square inch per second, plus or minus 10 pounds per square inch.
      b. Use automatic adhesion test equipment.
      c. Perform tests to coating or glue failure or maximum test load, whichever happens first.
      d. In accordance with ASTM D4541 using standard 20 millimeter dollies.
      e. Base adhesion testing on 3 tests.
         1) Conduct the tests by the same person, test equipment, and test procedure.
         2) Complete the tests within a 30 minute period.

f. Conduct adhesion tests within an area not to exceed 6 inches by 6-inches.
g. Score coatings with more than 10 percent elongation or 25 mils thick around dolly to metal substrate using manual methods and tools, normal to the pipe surface, and in a manner that does not stress or overheat the coating.

2. Attach dollies for adhesion testing to the coating surface using a 2 part epoxy or cyanoacrylate glue and cured for a minimum of 12 hours before testing or until full cure, whichever is greater.
   a. Pipe fabricator and coating manufacturer determine glue type for the pipe diameter, temperatures, and environmental conditions.
3. Perform adhesion testing at temperatures between 55 and 90 degrees Fahrenheit or at temperatures in accordance with coating manufacturer’s requirements.
   a. Testing up to 115 degrees Fahrenheit or below 55 degrees Fahrenheit will be permitted if tests can demonstrate no statistically detectable effect on test results and in accordance with coating manufacturer’s requirements and Engineer‘s approval.
4. Epoxy coating and lining adhesion criteria:
   a. Coating is acceptable if first dolly pull test exceeds 1,750 pounds per square inch, minimum.
   b. If first dolly pull is less than 1,750 pounds per square inch, perform 2 additional tests with acceptance based on "Best of 3" evaluation method as defined in this Section.
5. Pipe lot performance criteria:
   a. Minimum median value for coating or lining adhesion tests: 2,000 pounds per square inch.
   b. Classify failing pipe lots as rejected until 100 percent of the pipe within the pipe lot has been tested for adhesion.
      1) Reject each pipe that fails the coating adhesion criteria.
6. Adhesion test evaluation and records:
   a. Definition: "Best of 3" evaluation method is when 2 of 3 test values meet the adhesion criteria.
   b. Consider adhesion tests as valid and suitable for acceptance or rejection of the coating, except where retesting is required.
   c. Adhesion test failure:
      1) Adhesive or substrate failure.
         a) Definition: A percentage of separation of the coating from the steel substrate or between distinct coating layers.
      2) Cohesive test failure:
         a) Definition: A percentage of failure within the coating, resulting in coating remaining both on the steel substrate and test dolly.
   d. Retest coating adhesion tests:
      1) When any test is glue failure at 25 percent or more of dolly surface area and the test value is less than the Acceptance Criteria or the Minimum Criteria.
      2) Within the same 6-inch by 6-inch test area as the original adhesion testing.
      3) Retest disputed adhesion tests.
         a) Owner's representative will witness dolly attachment and adhesion retesting.

e. Adhesion tests will be conducted on pipe coating and lining independently and will be accepted or rejected independently.
f. Maintain adhesion test records in an electronic spreadsheet that includes the following information:
1) Pipe identification.
2) Pipe coating date.
3) Adhesion test date.
4) Surface tested (interior or exterior).
5) Surface temperature at time of test.
6) Coating thickness.
7) Tensile force applied.
8) Applied load rate per second.
9) Mode of failure.
10) Percentage of failure types, previously defined, relative to dolly surface area.
11) Dolly size and attachment glue used.
12) If different coatings are tested, include coating manufacturer and product number.

7. Adhesion test repairs:
a. Fabricator or contractor to complete adhesion repairs as specified this Section.
b. Randomly select repair patches on epoxy or polyurethane coating for adhesion testing in a manner as described in this Section and at the discretion of the coating inspector.

F. Long term adhesion test:
1. Acceptance criteria:
a. Not more than 10 percent loss of adhesion over duration of test.
b. Differential based on the highest average adhesion result to the lowest average adhesion result.
2. Test durations, cumulative:
a. 1 day.
b. 7 days.
c. 3 weeks.
d. 2 months.
3. Sample preparation:
a. SSPC-SP 5, 3.00 mils profile, minimum.
b. Test area minimum: 18-inches by 18-inches.
c. Curved steel plate.
1) Minimum radius of 15-inches.
2) Inclined between 30 and 45 degrees.
4. Test procedure:
a. Expose samples to ambient, outdoor conditions, and facing in a southern direction for maximum UV exposure for the full duration of the test.
5. Adhesion test results:
a. Based on 8 pulls per test period with the 3 lowest pulls discarded.
b. Based an average of the 5 highest pulls and identify the values used.
6. Record adhesion pulls and their failure mode.
7. Repair sample after adhesion tests to prevent water from causing any effects on subsequent adhesion tests.

G. Perform high voltage holiday detection test in accordance with NACE SP0188, over 100 percent of coated surfaces to ensure pinhole free finished coating system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Joints:
   1. Steel pipe joints shall be screwed, welded, flanged, grooved, or made with flexible joints. The type of joint for piping is specified in the Piping Schedule in Section 40_05_00.01 - Common Work Results for General Piping.
   2. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means necessary to allow ready assembly and disassembly of the piping.
   3. Unless otherwise indicated on the Drawings or specified in the Piping Schedule in Section 40_05_00.01 - Common Work Results for General Piping, pipe joints shall be as follows:
      a. Pipe smaller than 2 inches in nominal diameter shall have screwed joints or flexible couplings.
      b. Pipe 2 inches to 4 inches in nominal diameter shall have screwed joints, flanged joints, welded joints, or joints made with flexible couplings.
      c. Pipe larger than 4 inches in nominal diameter shall have flanged joints, welded joints, or joints made with flexible couplings.

B. Screwed joints:
   1. Perform threading with clean, sharp dies.
      a. Wavy, rough, or otherwise defective pipe threads are not acceptable.
   2. Make screwed joints tight and clean with an application of Teflon™ tape or approved paste compound applied to the male threads only, except as follows:
      a. Make up liquid and dry chlorine lines, and liquefied petroleum gas lines, with litharge and glycerin.
   3. Provide railroad type unions with bronze-to-iron seat, galvanized where used with galvanized pipe.
      a. Flanged joints may be used instead of unions.

C. Flanged joints:
   1. In flanged joints, flanges shall come together at the proper orientation with no air gaps between the flanges after the gaskets are in place.
   2. Attach slip-on flanges to pipe by 2 fillet welds, in accordance with AWWA C207.
   3. Secure welding neck flanges with full penetration butt welds without backing rings.
      a. After welding in place, the faces of flanges shall be perpendicular to the axis of the pipe, or, in the case of fittings, at the proper angle to each other, and bolt holes shall be in proper alignment.

D. Welded joints:
   1. Welded joints shall be electric welded in accordance with AWWA C206.

2. Welders shall be qualified pursuant to the provisions of AWWA C206.
    a. Welders' testing shall be at the Contractor's expense, including cost of test nipples, welding rods, and equipment.
3. Do not weld galvanized pipe.

E. Grooved joints:
1. Piping with grooved joints shall be installed where indicated on the Drawings and may be installed in place of flanged piping and screwed piping, except that grooved joint piping shall not be used in the following installations:
    a. In underground and underwater installations.
    b. In piping subject to test pressures of 150 pounds per square inch gauge, or more.
    c. In steam and gas piping.
    d. In sludge and scum piping designed to be steam cleaned.
2. Assemble in accordance with manufacturer's published instructions.
3. Support grooved-end pipe in accordance with manufacturer's recommendations. In addition, provide at least 1 support between consecutive couplings.

3.02 DEFECTS IN COATINGS EXCEPT CEMENT MORTAR

A. Engineer will identify defective coating to be field repaired in accordance with the applicable AWWA standard.
1. Pipe joints exceeding the following defect maximum will be rejected.
    a. Minor defects:
        1) No more than 1.5 per 100 square feet of surface area.
        2) 2 or more minor repairs within an 8-inches diameter circle will be considered a single repair.
        3) Repairs for adhesion testing will not be included in the total number of repairs.
        4) Repair in accordance with manufacturer's requirements.
    b. Major defects:
        1) No more than 3 major repairs on each pipe joint.
        2) No more than 30 percent repairs on the pipe surface area with defects.
2. Minor repairs:
    a. Repairs less than 8-inches in the greatest dimension.
    b. Repair in accordance with manufacturer's requirements.
3. Major repairs:
    a. Repairs that exceed 8-inches in the greatest dimension.
    b. Repair in accordance with manufacturer's requirements.

3.03 PLURAL COMPONENT POLYURETHANE

A. Joints:
1. Field applied coating or lining shall be of the same density, smoothness, and thickness as shop applied coating or lining.
2. Comply with same application requirements as shop applied coating or lining.
    a. Provide heating and/or dehumidification equipment as required to meet the environmental conditions necessary for proper coating application.

3.04 FIELD QUALITY CONTROL

A. Field test fabricated steel manifolds with the pipe to which they connect.

B. Weld testing:
   1. Liquid penetrant testing:
      a. As soon as possible after welding of pipeline joints, all fillet welds shall be tested by the liquid penetrant inspection procedure in accordance with ASTM E165 under Method “B” and “Leak Testing”.
      b. Chip out defects, rebell, and retest.
         1) Upon retest, the repaired area shall show no leaks or other defects.

END OF SECTION

SECTION 40_05_24.02

STEEL PIPE: ASTM A53

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Steel pipe: Galvanized and black, ASTM A53.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.3 - Malleable-Iron Threaded Fittings: Classes 150 and 300.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.
   3. B16.9 - Factory-Made Wrought Buttwelding Fittings.
   4. B16.11 - Forged Fittings, Socket-Welding and Threaded.

B. American Water Works Association (AWWA):
   1. C110 - Ductile-Iron and Gray-Iron Fittings.
   2. C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied.
   3. C205 - Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4 Inches and Larger-Shop Applied.
   4. C206 - Field Welding of Steel Water Pipe.
   5. C210 - Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
   6. C214 - Tape Coatings for Steel Water Pipe.
   7. C216 - Heat-Shrinkable Cross-Linked Polyolefin Coatings for Steel Water Pipe and Fittings.
   8. C217 - Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings.
   9. C222 - Polyurethane Coatings and Linings for Steel Water Pipe and Fittings.
   10. C606 - Standard for Grooved and Shouldered Joints.

C. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Casting.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
   4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
   6. A536 - Standard Specification for Ductile Iron Castings.
   7. C150 - Standard Specification for Portland Cement.
   8. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

9. D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
10. E165 - Standard Practice for Liquid Penetrant Testing for General Industry.

D. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.

E. Society for Protective Coatings (SSPC):
1. SP 1 - Solvent Cleaning.
2. SP 3 - Power Tool Cleaning.
3. SP 5 - White Metal Blast Cleaning.
4. SP 6 - Commercial Blast Cleaning.
5. SP 10 - Near White Wet Blast.
6. SP 11 - Bare Metal Power Tool Cleaning.
7. QP 1 - Industrial Contractor Qualification.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_00.01 - Common Work Results for General Piping.

C. Manufacturer's qualifications.
1. Manufacturer qualifications and list of projects using the specified material: 5 years minimum.

D. Manufacturer's Quality Assurance Manual.
1. Submit manufacturer's coating and lining application quality assurance manual to the Engineer prior to beginning coating application.
   a. Strict conformance to the requirements of the manual will be required.
   b. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Steel pipe:
1. General:
   a. In accordance with ASTM A53.
      1) Type E - electric-resistance welded or Type S - seamless.
      2) Grade A or B.
   b. Schedule:
      1) As indicated on the Drawings or as specified in Section 40_05_00.01 - Common Work Results for General Piping pipe schedule.

B. Pipe fittings:
   1. Flanged and welding fittings:
      a. Butt-weld fittings in accordance with ASME B16.9.
      b. Schedule of fittings: Same class or thickness as the pipe to which it connects.
   2. Screwed fittings:
      a. Malleable iron:
         1) Class 150 or Class 300 in accordance with ASME B16.3, as specified in Section 40_05_00.01 - Common Work Results for General Piping pipe schedule.
         2) Galvanized in accordance with ASTM A153 where used with galvanized pipe.
   3. Grooved joint fittings:
      a. Fittings for grooved joint steel piping: Rigid-grooved type.
      b. Fittings for grooved joint piping:
         1) Manufacturers: One of the following or equal:
            a) Victaulic Co. of America.
         2) Ductile iron fittings:
            a) Larger than 4 inches in diameter: In accordance with ASTM A536, Grade 65-45-12, long radius, in accordance with AWWA C110.
            b) Less than 4 inches in diameter: Malleable iron in accordance with ASTM A47, Grade 32510.
         3) Where cast fittings are not made, forged steel in accordance with ASME B16.9, ASTM A105, Grade B with 0.375-inch minimum wall thickness.
            a) Bends: Long radius.
         4) Furnished by the manufacturer of the grooved joint coupling.
         5) For rigid-grooved type joints.
         6) Connection to flanged units shall be by means of a spool with one end flanged and the other grooved, long enough to prevent interference with adjacent valves, pumps, or other items, minimum length, 4 inches.

C. Pipe joints:
   1. General:
      a. Use type of pipe joints as indicated on the Drawings or as specified in Section 40_05_00.01 - Common Work Results for General Piping pipe schedule.
      b. In addition to the type of pipe joints indicated on the Drawings or as specified in Section 40_05_00.01 - Common Work Results for General Piping pipe schedule, use flexible couplings, unions or flanged joints to allow ready assembly and disassembly of the piping.
   2. Flanged joints:
      a. In accordance with ASME B16.5, steel, 150 pounds, slip-on or weld neck, galvanized in accordance with ASTM A153 where used with galvanized pipe.
      b. Companion flanges:
         1) In accordance with ASME B16.5, steel.
         2) Class 150 pounds, slip-on or welding neck.
      c. Weld flanges to pipe or fittings before applying lining.

d. Machine flanges or provide tapered filler for changes in grade or to slope lines for drainage.
e. Match pipe flanges to the valve flanges.
f. Flange bolts: As specified in Section 40_05_00.01 - Common Work Results for General Piping.
g. Gaskets: As specified in Section 40_05_00.01 - Common Work Results for General Piping.

3. Grooved joints:
   a. Grooves: Cut grooves. Rolled grooves are not acceptable.
   b. Couplings housing: Cast in 2 or more segments of ductile iron in accordance with ASTM A536, Grade 65-45-12 or malleable iron in accordance with ASTM A47, Grade 32510.
   c. Bolts and nuts: In accordance with ASTM A183, Grade 2.
   d. Gaskets: Composition water sealing designed so that the internal piping pressure serves to increase the seal's watertightness.
      1) Gaskets for water service and oil-free air systems at temperatures less than 230 degrees Fahrenheit shall be made of ethylene propylene diene monomers (EPDM) in accordance with ASTM D2000 Line Call Out 2CA615A25B24.
      2) Gaskets for use with cement-mortar lined steel piping shall be captured between the ends of the pipe to protect exposed metal from corrosion and shall be made of neoprene in accordance with ASTM D2000.
   e. Perform grooving of the pipe wall only on standard or heavier schedule weight pipe.
      1) For pipe with wall thickness less than standard weight, weld a shouldered end on the pipe in accordance with AWWA C606.
      2) Shoulder: Type B or D in accordance with AWWA C606.
   f. Couplings and grooving:
      1) Manufacturers: One of the following or equal:
         a) Victaulic Co.
   g. Grooved joint piping shall not be used in the following installations:
      1) In underground and underwater installations.
      2) In piping subject to test pressures of 150 pounds per square inch gauge, or more.
      3) In steam and gas piping.
      4) In sludge and scum piping designed to be steam cleaned.
4. Welded joints: Butt welds, 2 pass, full depth with beveled ends and no backing rings.

2.02 COATING AND LINING - GENERAL

A. Coating and lining shall be as indicated on the Drawings or as specified in Section 40_05_00.01 - Common Work Results for General Piping.

B. Extend pipe coatings for underground piping 6 inches above finished grade or 3 inches above finished floor, and neatly terminate.

C. As specified in Section 01_60_00 - Product Requirements.

D. Prepare, install, and repair in accordance with manufacturer's requirements.

E. Contractor is responsible for:
    1. Material selection suitable for the application conditions anticipated, such as temperature, humidity, etc.
    2. Managing the project schedule to allow adequate cure time before backfill or immersion based on surface temperatures at the time of application.

2.03 CEMENT MORTAR

A. Line pipe with cement mortar in accordance with AWWA C205 and as specified in this Section.
    1. Cement:
        a. In accordance with ASTM C150, Type II.
    2. Water:
        a. In accordance with AWWA C205 and as specified in this Section.
    3. Sand and aggregate:
        a. In accordance with AWWA C205, except that the total percentage of deleterious material shall not exceed 3 percent.

B. Application location:
    1. Shop apply cement-mortar lining in accordance with AWWA C205.

C. Lining:
    1. Line special pieces or fittings by mechanical, pneumatic, or hand placement.
        a. Extend to faces of flanges and ends of spigots.
        b. Less than 12 inches in width: Coat with epoxy bonding agent prior to applying cement mortar.
        c. Larger than 12 inches in width: Reinforced with 2-inch by 4-inch No. 13 gauge welded steel wire mesh prior to applying cement mortar.
    2. Provide plastic end caps of sufficient thickness and strength to resist shipping, handling, and storage stresses.
    3. Repair damage to the cement mortar lining, including disbondment, or cracking caused by improper curing, shipping, handling, or installation in accordance with AWWA C205 and approved by the Engineer.
        a. Reinforce coating with 2 layers spirally-wound steel wire positioned approximately in center of mortar coating positioned approximately at the third points of mortar coating:
            1) No. 12 gage spaced at maximum 1-inch centers.
            2) No. 14 gage steel wire at maximum 1/2-inch centers.

2.04 PLURAL COMPONENT EPOXY

A. Line pipe with plural component, 100 percent solids, non-extended in accordance with AWWA C210 and as specified in this Section.

B. Surface preparation:
    1. In accordance with SSPC-SP 10 or SSPC-SP 11.
    2. In accordance with AWWA C210 and as specified in this Section.
        a. Steel pipe: SSPC-SP 5, 3.00 mils profile, minimum, or in accordance with manufacturer’s requirements, whichever is greater.

C. Primer: In accordance with coating manufacturer’s requirements.

D. High build epoxy coating:
   1. 2 component, high build polyamide or polyamine cured epoxy coating, suitable for direct burial or immersion, dries to touch in 2 or more hours, suitable for immersion or burial after full cure of coating.
   2. Manufacturers: One of the following or equal:
      a. Carboline.
      b. ICI Devoe.
      c. Sherwin Williams.
      d. Warren Environmental.

E. Fast cure epoxy coating:
   1. 2 component, 100 percent solids by volume, fast cure epoxy coating suitable for direct burial or immersion, dry to touch in less than 1 hour at 72 degrees Fahrenheit, capable of curing while immersed or buried.
   2. Manufacturers: One of the following or equal:
      a. North American Denso, Protal 7125 or Protal 7200.
      b. Tapecoat Inc., TC 7010.

F. Application:
   1. Apply coating using plural component spray equipment by a manufacturer certified coating applicator.
   2. Perform coating application in an environmentally controlled shop area that meets or exceeds the written environmental application requirements of the coating manufacturer.
      a. It is not acceptable to apply coating in outdoor conditions without adequate environmental shelter, environmental controls, and/or dehumidification.
   3. In potable water applications, provide epoxy lining suitable for potable water contact in accordance with NSF 61, unless otherwise approved by the Engineer.
   4. Concrete embedded pipe penetrations: Extend epoxy coating a minimum of 6 inches outside of interior and exterior surfaces of concrete walls or floors.
   5. Concrete penetrations minimum dry film thickness: 12 mils.
   6. Apply heat shrink sleeves to buried transitions from epoxy to tape wrap or extruded polyolefin coating systems.
      a. Backfill as soon as practical to limit exposure to direct sun or heat and potential thermal creep of sleeve.

G. Self-priming, plural component, 100 percent solids, suitable for burial or immersion, and in accordance with AWWA C210 and the following, whichever is more stringent:
   1. Non-NSF certified: Ceramic fill.
   2. NSF certified: Poly amine epoxy or poly amide epoxy.
   3. Shop applied coating thickness:
      a. Minimum: 1 coat, 35 mils total dry film thickness.
   4. Shop applied lining thickness:
      a. Minimum: 1 coat, 35 mils total dry film thickness.

H. Adhesion test procedures:
   1. Use self-aligning pneumatic pull off equipment and test procedures in accordance with ASTM D4541, Method E, using Delfesko Positest AT-A except as modified in this Section.
      a. Perform at an applied load rate of 100 pounds per square inch per second, plus or minus 10 pounds per square inch.

b. Use automatic adhesion test equipment.
c. Perform tests to coating or glue failure or maximum test load, whichever happens first.
d. In accordance with ASTM D4541 using standard 20-millimeter dollies.
e. Base adhesion testing on 3 tests.
    1) Conduct the tests by the same person, test equipment, and test procedure.
    2) Complete the tests within a 30-minute period.
f. Conduct adhesion tests within an area not to exceed 6 inches by 6 inches.
g. Score coatings with more than 10 percent elongation or 25-mils thick around dolly to metal substrate using manual methods and tools, normal to the pipe surface, and in a manner that does not stress or overheat the coating.

2. Attach dollies for adhesion testing to the coating surface using a 2-part epoxy or cyanoacrylate glue and cured for a minimum of 12 hours before testing or until full cure, whichever is greater.
    a. Pipe fabricator and coating manufacturer determine glue type for the pipe diameter, temperatures, and environmental conditions.
3. Perform adhesion testing at temperatures between 55 and 90 degrees Fahrenheit or at temperatures in accordance with coating manufacturer's requirements.
    a. Testing up to 115 degrees Fahrenheit or below 55 degrees Fahrenheit will be permitted if tests can demonstrate no statistically detectable effect on test results and in accordance with coating manufacturer's requirements and Engineer's approval.
4. Epoxy coating and lining adhesion criteria:
    a. Coating is acceptable if first dolly pull test exceeds 1,750 pounds per square inch, minimum.
    b. If first dolly pull is less than 1,750 pounds per square inch, perform 2 additional tests with acceptance based on "Best of 3" evaluation method as defined in this Section.
5. Pipe lot performance criteria:
    a. Minimum median value for coating or lining adhesion tests: 2,000 pounds per square inch.
    b. Classify failing pipe lots as rejected until 100 percent of the pipe within the pipe lot has been tested for adhesion.
        1) Reject each pipe that fails the coating adhesion criteria.
6. Adhesion test evaluation and records:
    a. Definition: "Best of 3" evaluation method is when 2 of 3 test values meet the adhesion criteria.
    b. Consider adhesion tests as valid and suitable for acceptance or rejection of the coating, except where retesting is required.
    c. Adhesion test failure:
        1) Adhesive or substrate failure.
            a) Definition: A percentage of separation of the coating from the steel substrate or between distinct coating layers.
        2) Cohesive test failure.
            a) Definition: A percentage of failure within the coating, resulting in coating remaining both on the steel substrate and test dolly.

d. Retest coating adhesion tests:
    1) When any test is glue failure at 25 percent or more of dolly surface area and the test value is less than the acceptance criteria or the minimum criteria.
    2) Within the same 6-inch by 6-inch test area as the original adhesion testing.
    3) Retest disputed adhesion tests.
        a) Owner's representative will witness dolly attachment and adhesion retesting.
e. Adhesion tests will be conducted on pipe coating and lining independently and will be accepted or rejected independently.
f. Maintain adhesion test records in an electronic spreadsheet that includes the following information:
    1) Pipe identification.
    2) Pipe coating date.
    3) Adhesion test date.
    4) Surface tested (interior or exterior).
    5) Surface temperature at time of test.
    6) Coating thickness.
    7) Tensile force applied.
    8) Applied load rate per second.
    9) Mode of failure.
    10) Percentage of failure types, previously defined, relative to dolly surface area.
    11) Dolly size and attachment glue used.
    12) If different coatings are tested, include coating manufacturer and product number.

7. Adhesion test repairs:
    a. Fabricator or Contractor to complete adhesion repairs as specified in this Section.
    b. Randomly select repair patches on epoxy or polyurethane coating for adhesion testing in a manner as described in this Section and at the discretion of the coating inspector.

l. Long term adhesion test:
1. Acceptance criteria:
    a. Not more than 10 percent loss of adhesion over duration of test.
    b. Differential based on the highest average adhesion result to the lowest average adhesion result.
2. Test durations, cumulative:
    a. 1 day.
    b. 7 days.
    c. 3 weeks.
    d. 2 months.
3. Sample preparation:
    a. SSPC-SP 5, 3.00 mils profile, minimum.
    b. Test area minimum: 18-inches by 18-inches.
    c. Curved steel plate.
        1) Minimum radius of 15-inches.
        2) Inclined between 30 and 45 degrees.

4. Test procedure:
    a. Expose samples to ambient, outdoor conditions, and facing in a southern direction for maximum UV exposure for the full duration of the test.
5. Adhesion test results:
    a. Based on 8 pulls per test period with the 3 lowest pulls discarded.
    b. Based an average of the 5 highest pulls and identify the values used.
6. Record adhesion pulls and their failure mode.
7. Repair sample after adhesion tests to prevent water from causing any effects on subsequent adhesion tests.

2.05 FABRICATION

A. Shop coat of primer:
    1. Flanges and portions of pipe not covered with cement-mortar shall be given a shop coating of primer.
    2. Primer compatible with finish coating system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Joints:
    1. General:
        a. Steel pipe joints shall be screwed, welded, flanged, grooved, or made with flexible joints. Type of joint for piping is as specified in Section 40_05_00.01 - Common Work Results for General Piping pipe schedule or as indicated on the Drawings.
        b. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means necessary to allow ready assembly and disassembly of the piping.
        c. Unless otherwise indicated on the Drawings or as specified in Section 40_05_00.01 - Common Work Results for General Piping pipe schedule, pipe joints shall be as follows:
            1) Pipe smaller than 2 inches in nominal diameter shall have screwed joints, welded joints, unions, or flexible couplings.
            2) Pipe 2 inches to 4 inches in nominal diameter shall have screwed joints, flanged joints, welded joints, or joints made with flexible couplings.
            3) Pipe larger than 4 inches in nominal diameter shall have flanged joints, welded joints, or joints made with flexible couplings.
    2. Flanged joints:
        a. Flanges shall come together at the proper orientation with no air gaps between the flanges after the gaskets are in place.
        b. Secure welding neck flanges with full penetration butt welds without backing rings.
        c. Secure slip-on flanges with both internal and external welds.
        d. After welding in place, the faces of flanges shall be perpendicular to the axis of the pipe, or, in the case of fittings, at the proper angle to each other, and bolt holes shall be in proper alignment.

3. Grooved joints:
    a. Assemble in accordance with manufacturer's published instructions.
    b. Support grooved joint pipe in accordance with manufacturer's recommendations. In addition, provide at least 1 support between consecutive couplings.
4. Screwed joints:
    a. Perform threading with clean, sharp dies.
        1) Wavy, rough, or otherwise defective pipe threads are not acceptable.
    b. Make screwed joints tight and clean with an application of Teflon™ tape or paste compound applied to the male threads only, except as follows:
        1) Make up liquid and liquefied petroleum gas lines, with litharge and glycerin.
    c. Provide railroad type unions with bronze-to-iron seat. Galvanized where used with galvanized pipe.
        1) Flanged joints may be used instead of unions.
5. Welded joints:
    a. Field welded joints: Electric arc welded in accordance with AWWA C206.
    b. Welder's qualification: Qualified in accordance with AWWA C206.
        1) Welders' testing shall be at the Contractor's expense, including cost of test nipples, welding rods, and equipment.
    c. Do not weld galvanized pipe.

3.02 DEFECTS IN COATINGS EXCEPT CEMENT MORTAR AND TAPE WRAP

A. Engineer will identify defective coating to be field repaired in accordance with the applicable AWWA standard.
    1. Pipe joints exceeding the following defect maximum will be rejected.
        a. Minor defects:
            1) No more than 1.5 per 100 square feet of surface area.
            2) 2 or more minor repairs within an 8-inches diameter circle will be considered a single repair.
            3) Repairs for adhesion testing will not be included in the total number of repairs.
            4) Repair in accordance with manufacturer's requirements.
        b. Major defects:
            1) No more than 3 major repairs on each pipe joint.
            2) No more than 30 percent repairs on the pipe surface area with defects.
    2. Minor repairs:
        a. Repairs less than 8 inches in the greatest dimension.
        b. Repair in accordance with manufacturer's requirements.
    3. Major repairs:
        a. Repairs that exceed 8 inches in the greatest dimension.
        b. Repair in accordance with manufacturer's requirements.

3.03 CEMENT MORTAR

A. Lining:
    1. Field applied interior joint lining:
        a. Field applied lining shall be of the same density, smoothness, and thickness as shop applied lining.

b. After the backfill has been completed to final grade, fill interior joint recess with tightly packed cement mortar.
    1) Trowel flush with the interior surface with no indentation or projection of the mortar exceeding 1/16-inch.
    2) Remove excess cement mortar.

3.04 PLURAL COMPONENT EPOXY

A. Joints:
    1. Field applied coating or lining shall be of the same density, smoothness, and thickness as shop applied coating or lining.
    2. Comply with same application requirements as shop applied coating or lining.
        a. Provide heating and/or dehumidification equipment as required to meet the environmental conditions necessary for proper coating application.

3.05 FIELD COAT

A. Aboveground steel pipe as specified in Section 09_96_01 - High-Performance Coatings.

3.06 FIELD QUALITY CONTROL

A. Field test fabricated steel manifolds with the pipe to which they connect.

B. Weld testing:
    1. Liquid penetrant testing:
        a. As soon as possible after welding of pipeline joints, fillet welds shall be tested by the liquid penetrant inspection procedure in accordance with ASTM E165 under Method “B” and “Leak Testing”.
        b. Chip out defects, rebell, and retest.
            1) Upon retest, the repaired area shall show no leaks or other defects.

END OF SECTION

SECTION 40_05_31.01

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Plastic pipe, tubing, and fittings for systems that are not plumbing systems.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.12 - Cast Iron Threaded Drainage Fittings.

B. ASTM International (ASTM):
   1. D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.
   2. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   3. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   4. D1869 - Standard Specification for Rubber Rings for Asbestos-Cement Pipe.
   5. D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated (SDR Series.
   6. D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   7. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   8. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   9. D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
   10. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   11. D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
   12. D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly(Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
   13. D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   14. D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
   15. D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
   16. D3350 - Standard Specification for Polyethylene Plastic Pipes and Fittings Materials.

17. D4101 - Standard Specification for Polypropylene Injection and Extrusion Materials.
18. F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
19. F439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
20. F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
21. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
22. F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
23. F645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.
24. F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
25. F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
   1. C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches to 12 Inches, for Water Transmission Distribution.

D. NSF International (NSF).

E. Plastics Pipe Institute (PPI):
   1. TR 31 - Underground Installation of Polyolefin Piping.

1.03 ABBREVIATIONS

A. ABS: Acrylonitrile-butadiene-styrene.

B. CPVC: Chlorinated polyvinyl chloride.

C. DR: Dimension ratio.

D. DWV: Drain, waste, and vent.

E. ID: Inside diameter of piping or tubing.

F. NPS: Nominal pipe size followed by the size designation.

G. NS: Nominal size of piping or tubing.

H. PE: Polyethylene.

I. PP: Polypropylene.

J. PVC: Polyvinyl chloride.

K. SDR: Standard dimension ratio; the outside diameter divided by the pipe wall thickness.

1.04 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_00.01 - Common Work Results for General Piping.

C. Shop Drawings:
   1. Describe materials, pipe, fittings, gaskets, and solvent cement.
   2. Installation instructions.

1.05 QUALITY ASSURANCE

A. Plastic pipe in potable water applications: Provide pipe and tubing bearing NSF seal.

B. Fusion machine technician qualifications: 1-year experience in the installation of similar PE piping systems from the same manufacturer.

C. Mark plastic pipe with nominal size, type, class, schedule, or pressure rating, manufacturer and all markings required in accordance with ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring, and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

C. Store and handle PE pipe and fittings as recommended by manufacturer in published instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except that fittings used in drain, waste, and vent piping systems need not be pressure rated.

C. Unions 2-1/2 inches and smaller: Socket end screwed unions. Make unions 3 inches and larger of socket flanges with 1/8-inch full-face soft neoprene gasket.

2.02 PVC PIPING, SCHEDULE TYPE

A. The requirements for PVC piping used in plumbing systems are found in Section 22_42_01 - Plumbing Systems.

B. Materials:
   1. PVC Pipe: Designation PVC 1120 in accordance with ASTM D1785 and appendices:
      a. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454 material in accordance with ASTM D1784.
   2. Fittings:
      a. Supplied by pipe manufacturer.
      b. Pressure fittings: In accordance with ASTM D2466 or ASTM D2467.
      c. DWV fittings: In accordance with ASTM D2665.
   3. Solvent cement: In accordance with ASTM D2564:
      a. Chemical service: For CPVC or PVC pipe in chemical service, provide the following primer and cement, or equal:
         1) Primer: IPS Corp., Type P70.
         2) Cement: IPS Corp., Type 724 cement or another cement certified by the manufacturer for chemical service.

2.03 PVC PIPING, CLASS TYPE

A. The requirements for PVC piping used in plumbing systems are found in Section 22_42_01 - Plumbing Systems.

B. PVC pipe, Class Type: In accordance with ASTM D2241:
   1. Thermoplastic pipe materials designation code: PVC 1120, 1220, or 2120.
   2. PVC compound: Class 12454 in accordance with ASTM D1784.
   3. Standard dimension ratio: SDR not greater than 26.

C. Fittings: Ductile iron with transition gasket sized to accommodate the outside pipe diameter.

D. PVC pipe, Class Type: In accordance with AWWA C900:
   1. Pressure Class: as scheduled in Section 40_05_00.01 - Common Work Results for General Piping with a minimum DR of 26.
   2. Fittings: Cast or ductile iron fittings as specified in Section 40_05_19.01 - Ductile Iron Pipe: AWWA C151, sized for the dimensions of the pipe being used.
   3. Joint design: Push-on or mechanical joint type as identified in Piping Schedule.
   4. Gaskets: Neoprene in accordance with ASTM D1869 or ASTM F477.

2.04 PVC GRAVITY SEWER PIPING

A. The requirements for PVC piping used in plumbing systems are found in Section 22_42_01 - Plumbing Systems.

B. Materials:
1. Polyvinyl chloride (PVC) gravity sewer pipe and fittings: In accordance with ASTM D3034 for piping NPS 15 and smaller diameter, and to ASTM F679 for piping NPS 18 and larger diameter:
a. Referenced standards apply as complemented and modified in this Section.
b. Fittings: Supplied by the pipe manufacturer.
2. PVC compounds: Class Number 12454, in accordance with ASTM D1784:
a. Stabilizers, antioxidants, lubricants, colorants, and other additives and fillers: Not to exceed 10 parts by weight per 100 of PVC resin in the compound.
3. Pipe NPS 15 and smaller diameter: Wall thickness SDR 26:
a. Joints: Push-on joints in accordance with ASTM D3212.
4. Pipe NPS 18 and larger diameter:
a. PVC compound: Cell classification 12454 in accordance with ASTM D1784.
b. Minimum wall thickness: Thickness T-1 in accordance with Table 1 in ASTM F679.
c. Joints: Integral bell gasketed joints in accordance with ASTM F679.
d. Bell: Fabricated from pipe sections, thickness of the wall of the bell equivalent to the pipe wall thickness.
e. Gasket ring: Locked into the bell.
f. Spigot end of the pipe: Marked by the manufacturer to identify the final in-place position of the spigot in the bell.
5. Fittings, including wyes, tees, elbow caps, plug adapters, and manhole waterstops: Same wall thickness as the pipe:
a. Fittings: Factory molded with joints and gaskets equal to those of the pipe.
6. Gasket: Neoprene in accordance with ASTM D3212 or ASTM F477:
a. Keep rubber gasket in place during pipe joining.
7. Gasket for connection to manhole: Stainless steel clamp with gasket or similar device to seal the penetration.

2.05 CPVC PIPING

A. Materials:
1. CPVC pipe: Schedule 40 or Schedule 80, as specified, in accordance with ASTM F441 and Appendix, CPVC 4120:
a. Pipe: Extruded from Type IV, Grade 1, Class 23447 material in accordance with ASTM D1784.
b. Manufacturers: One of the following or equal:
1) Charlotte Pipe and Foundry Co.
2) Eslon Thermoplastics, Inc.
3) GF Harvel.
2. Fittings: In accordance with ASTM F438 or ASTM F439 for pressure fittings, as appropriate to the service and pressure requirement:
a. Fittings: Supplied by the pipe manufacturer.
b. Manufacturers: One of the following or equal:
1) Colonial Engineering.
2) Eslon Thermoplastics, Inc.
3) Chemtrol.
4) Spears Manufacturing Co.

3. Solvent cement: In accordance with ASTM F493:
    a. For CPVC pipe in chemical service, utilize IPS Corp., Type 724 cement or another cement certified by the manufacturer for high strength hypochlorite service.

2.06 SOURCE QUALITY CONTROL

A. The requirements for PVC piping used in plumbing systems are found in Section 22_42_01 - Plumbing Systems.

B. PVC piping, Schedule Type:
    1. Mark pipe and fittings in accordance with ASTM D1785.

C. PVC piping, Class Type:
    1. Hydrostatic proof testing in accordance with AWWA C900: Test pipe and integral bell to withstand, without failure, two times the pressure class of the pipe for a minimum of 5 seconds.

D. PVC gravity sewer piping:
    1. Mark pipe and fittings in accordance with ASTM D3034. Also mark the production control code on pipe and fittings.

E. CPVC piping:
    1. Mark pipe and fittings in accordance with ASTM F441.

F. PP piping:
    1. The requirements for PP piping used in plumbing systems are found in Section 22_42_01 - Plumbing Systems.
    2. Test samples and testing: Cut test samples of pipe, 6 inches long, from full length sections and test by the method outlined in accordance with ASTM D2412:
        a. Deflect pipe at least 35 percent without failure. Stiffness at 5 percent deflection equals or exceeds 55 pounds per square inch after the test samples have been immersed in a 5 percent solution by weight of sulfuric acid and n-Heptain for a period of 24 hours prior to testing.
        b. Failure is defined as rupture of the pipe wall.
        c. Stiffness factor may be computed by the method outlined in accordance with ASTM D2412 or by dividing the load in pounds per linear inch by the deflection in inches and 5 percent deflection.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
    1. Where not otherwise specified, install piping in accordance with ASTM F645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
    2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.

3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of PVC piping, Schedule Type:
1. The requirements for PVC piping used in plumbing systems are found in Section 22_42_01 - Plumbing Systems.
2. Solvent weld joints in accordance with ASTM D2855:
a. For PVC pipe in chemical service use IPS Corp., Type 724 cement in accordance with manufacturer's instructions.
3. Install piping in accordance with manufacturer's published instructions.

C. Installation of PVC piping, Class Type:
1. Install piping in accordance with the Appendix of AWWA C900 complemented with manufacturer's published instructions.

D. Installation of PVC gravity sewer piping:
1. The requirements for PP piping used in plumbing systems are found in Section 22_42_01 - Plumbing Systems.
2. Install piping in accordance with manufacturer's published instructions, as modified and complemented in this Section.
3. Install pipe and fittings not later than 4 months after their manufacture.
4. Provide for contraction and expansion at joints with a gasket ring.
5. Provide plugs or caps for stubs and branch pipes left unconnected to laterals.
6. Lubricate and assemble joints in accordance with the pipe manufacturer's published instructions.
7. Make connections to manholes with a manhole gasket that prevents infiltration and exfiltration through the penetrations:
a. Provide opening for connection large enough to allow subsequent grouting around the manhole gasket.
b. Grout around the manhole gasket and seal the opening.

E. Installation of CPVC piping:
1. Clean dirt and moisture from pipe and fittings.
2. Bevel pipe ends in accordance with manufacturer's instructions with chamfering tool or file. Remove burrs.
3. Use solvent cement and primer formulated for CPVC:
a. For CPVC pipe in chemical service use IPS Corp., Type 724 cement in accordance with manufacturer's instructions.
4. Use primer on pressure and non-pressure joints.
5. Do not solvent weld joints when ambient temperatures are below 40 degrees Fahrenheit or above 90 degrees Fahrenheit unless solvent cements specially formulated for these conditions are utilized.

3.02 FIELD QUALITY CONTROL

A. Leakage test for PVC piping, Class Type:
1. The requirements for PVC piping used in plumbing systems are found in Section 22_42_01 - Plumbing Systems.

2. Polyvinyl chloride (PVC) piping, Class Type: Subject to visible leaks test and to pressure test with maximum leakage allowance, as specified in Section 40_05_00.09 - Piping Systems Testing.
3. Pressure test with maximum leakage allowance: Perform test after backfilling:
   a. Pressure: 125 pounds per square inch, gauge.
   b. Maximum leakage allowance as follows, wherein the value for leakage is in gallons per 100 joints per hour:

NPS, Inches	1-1/2	2	2-1/2	3	4	6	8	10	12
Leakage	0.41	0.52	0.63	0.76	0.98	1.45	1.88	2.35	2.80

B. Mandrel tests for PVC gravity sewer and HDPE piping:
1. The requirements for PVC piping used in plumbing systems are found in Section 22_42_01 - Plumbing Systems.
2. Perform initial mandrel test:
   a. After cleaning and completion of other tests.
   b. After placement and compaction of backfill.
   c. Before construction of pavement or surfacing.
   d. Not sooner than 30 days after pipe installation.
   e. Not later than 60 days after installation.
3. Utilize a 9 rod mandrel with minimum length equal to NPS and diameter as follows:

Nominal Pipe Size (NPS)	Mandrel Diameter, inches
6	5.50
8	7.37
10	9.21
12	10.96
15	13.56

4. Test procedure: Pull the mandrel through the line under test by 1 person, by hand, with reasonable effort, without the aid of mechanical equipment.
5. Failing test: Where the mandrel test is not successful, remove and replace the section of piping with the obstruction; test the piping again, including visible leaks test, pressure test with maximum leakage allowance, mandrel tests, and other specified tests:
   a. Correction of excessive deflection or obstructions by methods other than removal of the affected piping and replacement of the removed piping with new piping will not be accepted.

END OF SECTION

SECTION 40_05_31.14

POLYVINYL CHLORIDE (PVC) PIPE: PRESSURE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. AWWA C900 PVC pipe and fittings.

1.02 REFERENCES

A. Abbreviations:
   1. DR: Dimension ratio = OD/t (OD is pipe outer diameter, t is pipe wall thickness).
   2. NPS: Nominal pipe size followed by the size designation.

B. Standards:
   1. American Water Works Association (AWWA):
      a. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      b. C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
      c. C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In.
      d. M23 - PVC Pipe - Design and Installation Manual.
   2. ASTM International (ASTM):
      a. A536 - Standard Specification for Ductile Iron Castings.
      b. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
      c. D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
      d. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
      e. F645 - Standard Guide for Selection, Design, and Installation of Thermoplastic Water-Pressure Piping Systems.
   3. NSF International (NSF):
      a. 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. As specified in Section 40_05_00.01 - Common Work Results for General Piping.

C. Shop Drawings.

1.04 QUALITY ASSURANCE

A. Pipe in potable water applications: Provide pipe bearing NSF 61 seal.

B. Mark plastic pipe with date of extrusion, nominal size, class, manufacturer, and markings required in accordance with ASTM and AWWA standards.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect from sunlight, scoring, and distortion.

B. Do not allow surface temperatures to exceed 120 degrees Fahrenheit.

C. Deliver, offload, handle, and store pipe in accordance with manufacturer's or pipe supplier's recommendations and best practices provided by AWWA M23 and AWWA C605, including compliance with minimum recommended bending radius and maximum safe pulling forces for each specific pipe.

PART 2 PRODUCTS

2.01 PIPE

A. General:
   1. As specified in Section 40_05_00.01 - Common Work Results for General Piping.
   2. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.
   3. In accordance with AWWA C900.
   4. Made from a PVC compound conforming to cell classification 12454 in accordance with ASTM D1784.
   5. Marked verifying suitability for potable water service in accordance with NSF 61.

B. Pipe:
   1. Bell and spigot:
      a. Pipe with integral bell.
      b. Pressure Class as scheduled in Section 40_05_00.01 - Common Work Results for General Piping with a maximum DR of 26.
      c. Manufacturers: One of the following or equal.
         1) CertainTeed.
         2) Diamond Plastics Corp.
         3) Westlake Pipe and Fittings.

2.02 FITTINGS

A. Material:
   1. Cast or ductile iron fittings as specified in Section 40_05_19.01 - Ductile Iron Pipe: AWWA C151 sized for the dimensions of the pipe being used.

B. Equal to or greater pressure rating than the pipe.

2.03 JOINTS

A. Bell and spigot joints:
   1. Push-on or mechanical joint type as identified in the Piping Schedule in Section 40_05_00.01 - Common Work Results for General Piping.
   2. Gasketed joint assembly: Meet or exceed the requirements in accordance with ASTM D3139.
   3. Factory installed gaskets: SBR in accordance with ASTM F477.
   4. Joint restraint at fittings:
      a. Concrete thrust blocks:
         1) Install at changes in pipe diameter and at fittings.
         2) Design using a safety factor of at least 1.5:1 for both the test and peak operating pressures.
      b. Mechanical wedge action joint restraints:
         1) Manufacturers: One of the following or approved equal:
            a) EBAA Iron, Inc.:
               (1) For pipes 3- to 36-inch: Series 2000PV.
               (2) For pipes 42- and 48-inch: Series 2200.
            b) Sigma Corp.:
               (1) For pipes 3- to 36-inch: One-Lok Model SLCE.
               (2) For pipes 42- and 48-inch: PV-Lok Model PWM.
            c) Star Pipe Products, Series 4000.
         2) Materials:
            a) Mechanical joints bolts and nuts as specified in Section 40_05_00.01 - Common Work Results for General Piping.
            b) Gland body: Ductile iron in accordance with ASTM A536.
            c) Wedge and wedge actuating components: Ductile iron in accordance with ASTM A536.
               (1) Wedges: Heat-treated to a minimum of 370 BHN.
            d) Actuating bolts and nuts: Ductile iron in accordance with ASTM A536.
               (1) Provide torque-limiting twist off components to ensure proper installation.
         3) Coatings:
            a) Provide a manufacturer applied coating system.
            b) Manufacturers: One of the following or equal:
               (1) EBAA Iron Inc., Mega-Bond.
               (2) Sigma Corp., Corrsafe™ Electro-Deposition Coating.
               (3) Star Pipe Products, Star-Bond.
         4) Consist of multiple gripping wedges incorporated into a follower gland meeting the requirements in accordance with AWWA C111.

5) Allow post assembly angular deflection that is a minimum of 50 percent of the angular deflection allowed by the mechanical joint.
6) Pressure rating equal to or greater than that of the pipe on which it is being used and a minimum safety factor of 2:1 for all sizes.

2.04 SOURCE QUALITY CONTROL

A. Bell and spigot piping:
1. Hydrostatic proof testing in accordance with AWWA C900: Test pipe and integral bell to withstand, without failure, 2 times the pressure class of the pipe for a minimum of 5 seconds.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Install PVC piping in accordance with ASTM F645, AWWA C605, and manufacturer's or pipe supplier's published installation instructions.
2. Trenching and backfill as specified in Section 31_23_35 - Trenching.
3. Install pipe with tracer wire as specified in Section 40_05_00.03 - Pipe Identification.

3.02 FIELD QUALITY CONTROL

A. Leakage test for piping:
1. Subject to visible leak test and pressure test with maximum leakage allowance, as specified in Section 40_05_00.09 - Piping Systems Testing.
2. Pressure test with maximum leakage allowance:
a. Perform test after placing sufficient backfill.
b. In areas requiring immediate backfill, test prior to placement of permanent surfacing.
c. Test pressure: As specified in the Piping Schedule in Section 40_05_00.01 - Common Work Results for General Piping.

d. Maximum leakage allowance for bell and spigot pipe is as listed in the table below:

Test Pressure (psi)	Bell and Spigot Pipe Allowable Leakage (gallons per 50 joints per hour) Nominal Pipe Size (inches)									
	4	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**
50	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.96	1.15
75	0.23	0.35	0.47	0.59	0.70	0.82	0.94	1.05	1.17	1.40
100	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62
125	0.3	0.45	0.6	0.76	0.91	1.06	1.21	1.36	1.51	1.81
150	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99
175	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15
200	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29
225	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43
250	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56
275	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69
300	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81

END OF SECTION

SECTION 40_05_51.01

COMMON WORK RESULTS FOR VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Basic requirements for valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C111/A21.11 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe Fittings.

B. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   2. A480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   3. A536 - Standard Specification for Ductile Iron Castings.

C. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

D. Society for Protective Coatings (SSPC):
   1. SP 7 - Brush-Off Blast Cleaning.
   2. SP 10 - Near-White Blast Cleaning.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Submit the following information for each valve:
      a. Type, size, pressure rating, Cv factor.
      b. Coatings.
      c. Power valve actuators:
         1) Information on valve actuator, including size, manufacturer, model number, limit switches, mounting and motor enclosure, seating and unseating torque coefficient, dynamic torque, and bearing friction for calculation of maximum operating torque.
         2) Complete wiring diagrams and control system schematics.
      d. Manual valve actuators:
         1) Information on valve actuator, including size, manufacturer, and model number.

e. Certified drawings with description of component parts, dimensions, weights, and materials of construction.
f. Certifications of reference standard compliance:
    1) Submit certification that the valves and coatings are suitable in potable water applications in accordance with NSF 61.
g. Clearly mark Submittal information to show specific items, materials, and accessories or options being furnished.
h. Factory test data.

C. Provide vendor operation and maintenance manual as specified in Section 01_78_24 - Operation and Maintenance Manuals.
    1. Furnish bound sets of installation, operation, and maintenance instructions for each type of manual valve 4 inches in nominal size and larger, and non-manual valves. Include information on valve operators.

D. Provide Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.

E. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications:
    1. Valves manufactured by manufacturers whose valves have had successful operational experience in comparable service.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect valves and protective coatings from damage during handling and installation. Repair coating where damaged.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Pressure rating:
    1. Suitable for service under minimum working pressures of 150 pounds per square inch gauge.
    2. When a piping system is specified in the Pipe Schedule to be tested at a pressure greater than 150 pounds per square inch gauge, provide valves for that piping system with design working pressure which is sufficient to withstand the test pressure.

B. Valve to piping connections:
    1. Metallic valves:
        a. 3 inches nominal size and larger: Flanged ends.
        b. Less than 3 inches nominal size: Screwed ends.

2. Plastic valves in plastic piping systems:
    a. Up to 4 inches: Provide solvent or heat welded unions, except for plastic butterfly valves.
        1) Plastic butterfly valves shall be flanged as specified in Section 40_05_64 - Butterfly Valves.
    b. 6 inches and larger: Provide solvent or heat-welded flanges.

2.02 MATERIALS

A. Stainless steel: In accordance with ASTM A480, Type 316 or Type 304, UNS Alloy S31600 or S30400.

B. Valve and operator bolts and nuts, not including flange bolts and nuts as specified in Section 40_05_00.01 - Common Work Results for General Piping:
    1. Fabricated of stainless steel for the following installation conditions:
        a. Submerged in sewage or water.
        b. In an enclosed space above sewage or water.
        c. In structures containing sewage or water, below top of walls.
        d. At openings in concrete or metal decks.
    2. Where dissimilar metals are being bolted, use stainless steel bolts with isolation bushings and washers.
    3. Underground bolts: Low-alloy steel in accordance with AWWA C111/A21.11.

C. Bronze and brass alloys: Not more than 6 percent zinc and not more than 2 percent aluminum in the manufacture of valve parts.
    1. UNS Alloy C83600 or C92200 unless specified otherwise.

D. Cast iron valve bodies: In accordance with ASTM A126, Class 30 minimum.

E. Ductile iron valve bodies: In accordance with ASTM A536, Grade 65-45-12 minimum, unless specified otherwise.

2.03 INTERIOR PROTECTIVE LINING

A. When specified in the particular valve Specification, provide valves with type of protective lining specified in the particular valve Specification.

B. Apply protective lining to interior, non-working surfaces, except stainless steel surfaces.

C. Lining types:
    1. Fusion bonded epoxy:
        a. Manufacturers: The following or equal:
            1) 3-M Company, ScotchKote 134; certified in accordance with NSF 61 for drinking water use.
        b. Clean surfaces in accordance with SSPC-SP 7 or SSPC-SP 10, as recommended by the epoxy manufacturer.
        c. Apply in accordance with the manufacturer’s published instructions.
        d. Lining thickness: 0.010 to 0.012 inch, except that:
            1) In grooves for gaskets: 0.005 inch.
            2) Do not coat seat grooves in valves with bonded seat.

e. Quality control:
    1) Lining thickness: Measured with a non-destructive magnetic type thickness gauge.
    2) Verify lining integrity with a wet sponge-testing unit operating at approximately 60 volts, or as recommended by the lining manufacturer.
    3) Consider tests successful when lining thickness meets specified requirements and when no pinholes are found.
    4) Correct defective lining disclosed by unsuccessful tests and repeat test.
    5) Repair pinholes with liquid epoxy recommended by the manufacturer of the epoxy used for lining.

2. High solids epoxy:
    a. Product equivalent to high solids epoxy EPX-M-2 as specified in Section 09_96_01 - High-Performance Coatings.
        1) Certified in accordance with NSF 61 for drinking water use.
        2) Interior: Coat valve interior with the manufacturer's equivalent high performance high solids epoxy coating system with a certifiable performance history for the service conditions and as approved by the Engineer.
            a) Manufacturer shall provide for approval, coating information sufficient to allow the Engineer to assess equivalence to the specified high solids epoxy EPX-M-2 as specified in Section 09_96_01 - High-Performance Coatings.
    b. Clean surfaces in accordance with SSPC-SP 7 or SSPC-SP 10, or as recommended by the coating manufacturer.
    c. Quality control: After coating is cured, check coated surface for porosity with a holiday detector set at 1,800 volts, or as recommended by the coating manufacturer.
        1) Repair holidays and other irregularities and retest coating.
        2) Repeat procedure until holidays and other irregularities are corrected.

2.04 UNDERGROUND VALVES

A. Provide underground valves with flanged, mechanical, or other type of joint required for the type of pipe to which the valve is to be connected.

B. Coating and wrapping:
    1. After installation, encase valves in polyethylene wrap as specified for ductile iron piping in Section 40_05_19.01 - Ductile Iron Pipe: AWWA C151.
        a. Ensure polyethylene wrapping does not affect operation of valve.

2.05 STEAM VALVES

A. In steam or steam condensate piping: Ductile iron body in accordance with ASTM A536, Grade 65-45-12 minimum or cast steel or forged steel.

2.06 VALVE BOXES

A. Provide cast-iron valve boxes at each buried valve to access valve and valve operators.

B. Do not support boxes on valve, valve operator, or pipe.

C. Boxes:
   1. 2-piece, fabricated of cast iron; provide cover, with asphalt varnish or enamel protective coating.
   2. Adjustable to grade, install centered around the upper portions of the valve and valve operator.

D. Manufacturers: One of the following or equal:
   1. Neenah Foundry Co.
   2. Tyler Pipe Industries, Inc.

2.07 VALVE OPERATORS

A. Valve operator “Open” direction: Open counterclockwise.

B. Provide valves located below operating level or deck with extensions for key operation or floor stands and handwheels, as indicated on the Drawings.

C. Provide manually operated valves located not more than 6 feet above the operating level with tee handles, wrenches, or handwheels.
   1. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.
   2. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.

D. Fit valves located more than 6 feet above operating level with chain-operated handles or valve wheels.
   1. Chains: Sufficient length to reach approximately 4 feet above the operating level.
   2. Where chains constitute a nuisance or hazard to operating personnel, provide holdbacks or other means for keeping the chains out of the way.

E. Provide an operator shaft extension from valve or valve operator to finished grade or deck level when buried valves and other valves located below the operating deck or level are specified or indicated on the Drawings to be key operated.
   1. Provide 2 inches square AWWA operating nut, and box and cover as specified, or a cover where a box is not required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Preparation prior to installation:
   1. Determine after flanged valves and flanged check valves are selected, the face-to-face dimensions of flanged valves and flanged check valves.

B. Fabricate piping to lengths taking into account the dimensions of flanged valves and flanged check valves.

3.02 INSTALLATION

A. Install the valves in accordance with the manufacturer's installation instructions.

B. Provide incidental work and materials necessary for installation of valves, including flange gaskets, flange bolts and nuts, valve boxes and covers, concrete bases, blocking, and protective coating.

C. Provide additional valves for proper operation and maintenance of equipment and plant facilities under the following circumstances:
   1. Where such additional valves are required for operation and maintenance of the particular equipment furnished by the Contractor.
   2. Where such additional valves are required as a result of a substitution or change initiated by the Contractor.

D. Valve and actuator orientation:
   1. Coordinate with the valve supplier final orientation of valve and actuator assembly based on the Contractor's selection of equipment manufacturers and the valve and piping arrangement as indicated on the Drawings.
      a. Rotate valve and/or actuator mounting orientation as specified in this Section unless otherwise indicated on the Drawings.
   2. Install valves with their stems in vertical position above the pipe, except as follows:
      a. Butterfly valves, gate valves aboveground, globe valves, ball valves, and angle valves may be installed with their stems in the horizontal position.
      b. Install buried plug valves with geared operators with their stems in a horizontal position.
   3. Install valves so that handles clear obstructions when the valves are operated from fully open to fully closed.

E. Place top of valve boxes flush with finished grade or as otherwise indicated on the Drawings.

F. Valves with threaded connections:
   1. Install valves by applying wrench on end of valve nearest the joint to prevent distortion of the valve body.
   2. Apply pipe joint compound or Teflon™ tape on external (male) threads to prevent forcing compound into valve seat area.

G. Valves with flanged connections:
   1. Align flanges and gasket carefully before tightening flange bolts.
   2. When flanges are aligned, install bolts and hand tighten.
   3. Tighten nuts opposite each other with equal tension before moving to the next pair of nuts.

H. Valves with soldered connections:
   1. Do not overheat connection to prevent damage to resilient seats and metal seat rings.
   2. Position valves in full open position before starting soldering procedure.
   3. Apply heat to piping rather than to valve body.

3.03 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with the manufacturer's coating system and as specified in Section 09_96_01 - High-Performance Coatings.
   1. When shop-applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop-applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop-applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.04 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning, and this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

C. As specified elsewhere for specific valve types, sizes or actuators.
   1. Source testing.
   2. Manufacturers on-site services for Owner Training, Installation Testing, Functional Testing, and during the Process Operational Period.

END OF SECTION

SECTION 40_05_52

SPECIALTY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Specialty valves.

B. As specified in Section 40_05_51.01 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 25 - Earthquake-Actuated Automatic Gas Shutoff Devices.

B. American Society of Mechanical Engineers (ASME):
   1. B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. American Water Works Association (AWWA):
   1. C511 - Standard for Reduced Pressure-Principle Backflow-Prevention Assembly.
   2. C800 - Underground Service Line Valves & Fittings (Also Included: Collected Standards For Service Line Materials).

D. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A536 - Standard Specification for Ductile Iron Castings.
   5. B584 - Standard Specification for Copper Alloy Sand Castings for General Application.

E. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_51.01 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Backflow preventer certification.
   2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 SOLENOID VALVES

A. 2-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Co., Series 8210.
         1) Contractor shall provide external bypass to solenoid valve. External bypass shall use pipe of same material and size as main line and include a ball valve for manual operation.
      b. Skinner Electric Valve Division, Series C.

B. Design:
   1. Valves: Suitable for service under the following conditions:
      a. Fluid: As indicated in the Drawings.
      b. Temperature of fluid: 50-75 degrees Fahrenheit.
      c. Piping test pressure: As indicated in Pipe Schedule.
   2. Unless otherwise indicated on the Drawings, provide valves that meet the following requirements:
      a. Minimum NEMA Type 4 enclosure.
      b. 120 VAC operation.
      c. Suitable for use as indicated on the Drawings.
      d. Minimum Class F coil insulation.
   3. 2-way valves: Furnish with openings of size equal to or larger than the nominal size designation of the valve.
   4. Furnish with manual/bypass operators.

C. Materials:
   1. Body: Brass or bronze.
   2. Seats: Resilient material.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 40_05_51.01 - Common Work Results for Valves in accordance with manufacturer's published instructions.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning and this Section.

END OF SECTION

SECTION 40_05_57.24

ELECTRIC ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Electric motor-driven actuators for valves and gates.

B. Equipment tag numbers:
   1. As scheduled.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C504 - Standard for Rubber-Seated Butterfly Valves.
   2. C542 - Standard for Electric Motor Actuators for Valves and Slide Gates.

B. International Organization for Standardization (ISO):
   1. 12944 - Paints and Varnishes.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures and Section 01_60_00 - Product Requirements.

B. Provide a complete list/schedule of actuators being provided with their associated tag names, as indicated on the Drawings and/or Specifications, service process area and the size of the valve they are actuating.

C. Product data:
   1. Electrical ratings:
      a. Voltage and number of phases.
      b. Starting and running current.
      c. Voltage levels and source for control and status.
   2. Description of integral control interface.
   3. Remote control station components (If applicable).
   4. Environmental ratings, including NEMA enclosure rating and submergence capabilities.
   5. Gear ratios for both manual and motorized actuation.
   6. Opening and closing directions.
   7. Electric motor data.
   8. Allowable starts per hour.
   9. List of included options and accessories.

10. Full travel times.
11. Gearbox data, including gear ratio, and gearbox efficiency.

D. Shop Drawings:
   1. Wiring diagrams:
      a. Include options and expansion cards furnished with each actuator.
   2. Dimensioned drawings of each valve and actuator combination.
   3. Dimensioned drawings of each valve gearbox.

E. Calculations:
   1. Operating torque.
   2. Maximum torque calculations for seating and unseating.
   3. Maximum operating torque at starting and normal operation.

F. Installation instructions:
   1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
   2. Provide manufacturer's installation instructions.

G. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
   3. Manufacturer's Certificate of Installation as specified in Section 01_75_17 - Commissioning.
   4. Manufacturer's Certificate of Functional Compliance as specified in Section 01_75_17 - Commissioning.

H. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

I. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
   2. Include a list of configurable parameters and the final values for each.
   3. Include a troubleshooting chart covering the complete valve and controls/electrical power systems, showing description of trouble, probable cause, and suggested remedy.

1.04 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements, Section 46_05_10 - Common Work Results for Mechanical, and the manufacturer's instructions.

1.05 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.06 MAINTENANCE

A. As specified in Section 01_60_00 - Product Requirements.

B. Spare parts:
   1. Provide the following (minimum 10 percent of total number of actuators of each model type furnished, but not less than 1 for each model of actuator furnished):
      a. Stem nut.
      b. Worm shaft subassembly.
      c. Drive sleeve subassembly.
      d. Complete actuator seal kit.
      e. Actuator gearbox oil (sufficient quantity to fill 4 gearboxes).
      f. Encoder.
      g. Control module.

C. Setting tool:
   1. If required for setting or configuring the actuator, provide a handheld setting tool.
      a. Furnish 1 setting tool for every 10 actuators.
      b. Capable of communicating with PC-based configuration software and transferring the following in either direction between the computer and programmer and setting tool, and between the setting tool and actuator.
      c. Actuator configurations:
         1) Capable of storing up to 10 different configurations.
      d. Diagnostic data:
         Capable of storing 4 complete sets of diagnostic data.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Lines 3 inches and smaller:
   1. The following or equal:
      a. Rotork Controls Inc.
         1) ROMpak (Quarter-turn).

B. Lines 4 inches and larger:
   1. One of the following, or equal:
      a. Rotork Controls Inc. IQ3 Range:
         1) IQ for multi-turn applications.
         2) IQT for quarter-turn applications.

2.02 MATERIALS

A. Enclosures:
   1. Constructed of materials suitable for the environment where the actuator will be installed.
   2. Stainless steel external fasteners.

3. Provide O-ring seals for each of the following areas:
    a. Between the terminal compartment and the internal electrical elements.
    b. Between the mechanical and electrical portions to protect from the ingress of oil, and to protect the mechanical components of oil from dust and moisture when the electrical terminal is open.
4. Ratings
    a. As scheduled and specified:
    b. NEMA Type 6P: Double sealed and IP68 rated for prolonged submergence.
    c. XP: Factory Mutal (FM) approved for Class I, Division 1 and Division 2 locations.

B. Coatings:
1. Material requirements:
    a. Factory prime and coat with an ISO 12944 classification coating of C5M (Marine, offshore estuaries with high salinity) coating with 15 year durability.
    b. Touch-up damaged coatings with manufacturer provided coating repair kit.
2. Application requirements:
    a. Painting shall commence within 4 hours of blast cleaning.
    b. Each paint coat within the system is to be applied in accordance with the paint manufacturer’s instructions.
    c. Paint thickness shall be checked for each coat on each actuator.
3. Qualification requirements:
    a. Operators shall be experienced and proficient in surface preparation and coating application techniques.
    b. Personnel shall have relevant knowledge of health and safety hazard, use of protective equipment, coating materials, mixing and thinning coatings, coating pot life, surface requirements, etc.
    c. Personnel carrying out inspection or verification shall be certified as NACE coating inspector or equivalent such as ICorr.

2.03 CHARACTERISTICS FOR ACTUATORS ON LINES 3 INCHES AND SMALLER

A. Actuators for valves 3 inches and smaller:
1. Complete and operable with all components and accessories required for operation.
2. Power supply:
    a. Valve motion independent of power supply phase rotation.
    b. As indicated on the Drawings.
3. Size actuator to move valves from full open to closed position within the time indicated in the Actuator Schedule:
    a. If an operating time is not indicated on the Actuator Schedule, size the actuator to move valves at minimum 12 inches per minute under maximum load. Measure closure rate for valves at the maximum diameter of disc, plug, or ball.
4. For outdoor or vault installations, provide an integral anti-condensation heater when available as an option.
5. Control inputs:
    a. Capable of using discrete dry contacts.
    b. Controls the valve when local-stop-remote is in REMOTE.

c. Material: Type 316 stainless steel.
d. Provide the following inputs at the actuator:
1) OPEN.
2) CLOSE.

6. Status outputs:
a. Dry contact outputs configured for the functions indicated on the Drawings. Provide the following outputs for all actuators:
1) FULLY CLOSED.
2) FULLY OPEN.
3) REMOTE.
b. Output contacts rated for 1 amp, 24VDC.

7. Analog input:
a. Provide a 4 to 20 analog input for analog modulating valves when indicated on the Drawings.
b. Modulate valve to maintain position based on analog input value.
c. Maximum input impedance 250 ohms.

8. Analog output:
a. Provide an isolated 4 to 20 mA analog output when indicated on the Drawings.

9. Components:
a. Motors:
1) Torque ratings equal to or greater than that required for valve seating and dynamic torques with a 25 percent factor of safety.
2) Rated for operating under the following conditions without exceeding temperature limits with ambient temperature of 40 degrees Celsius.
a) Continuous operation for 15 minutes or twice the open-to-close operating time (whichever is greater) at normal operating torque or 33 percent of maximum torque (whichever is greater).
b) 60 starts per hour minimum for open/close service.
b. Manual actuation:
1) Handwheel for manual operation.
c. Gearing: Self-locking, high-alloy steel gears.

10. Communication options:
a. As specified in the Contract Documents.

2.04 CHARACTERISTICS FOR ACTUATORS ON LINES 4 INCHES AND LARGER

A. Provide actuators complete and operable with all components and accessories required for operation.

B. Power supply:
1. Voltage and phases as indicated in the Actuator Schedule.
2. Valve or gate motion independent of power supply phase rotation.
3. Provide an internal backup power source or mechanical indicator to maintain settings and track valve position when main power is off.
4. Actuators shall incorporate major components such as the motor, starter, local controls, terminals, etc., housed within a self-contained, sealed enclosure.

C. Size actuator to move gates or valves from full open to closed position within the time indicated in the Actuator Schedule:
    1. If an operating time is not indicated on the Actuator Schedule, size the actuator to move gates or valves at minimum 12 inches per minute under maximum load. Measure rate of closure for valves at maximum diameter of disc, plug, or ball.
    2. Size actuators so that gear boxes are not required where possible.

D. Control interface:
    1. Configuration:
        a. Provide a non-intrusive, non-contacting interface for configuring input and output settings, control values, ranges, torque switch settings, valve positions switch settings, and options.
            1) Configurable from a handheld configuring tool or input devices on the actuator.
    2. Local interface, integral to actuator:
        a. Non-intrusive, non-contacting selector switches:
            1) LOCAL-STOP-REMOTE:
                a) Motor actuator operation is prevented with the switch in STOP.
            2) OPEN-CLOSE:
                a) Controls the valve when LOCAL-STOP-REMOTE is in LOCAL.
                b) Spring return to center.
                c) Configurable between maintained (actuator runs until end of travel, high torque, or a LOCAL-STOP-REMOTE is switched to STOP) and momentary (actuator stops when lever is released).
        b. Local display:
            1) Valve fully open and fully closed indicators.
            2) Numerical display showing actual valve or gate position in percent of travel.
    3. Remote control station - (VCP):
        a. For actuators located more than 5 feet above finished floor/grade or where indicated on the Drawings in the Schedule.
            1) NEMA rating to match those to the associated Actuator Schedule.
                a) Where the rating is not listed, use NEMA Type 4X enclosures for non-hazardous areas, and explosion-proof (XP) Class I, Division 1 for hazardous areas.
                b) Pilot devices shall be 30 millimeters and pilot lights shall be illuminated by LEDs.
            2) LOCAL-STOP-REMOTE selector switch.
            3) LOCAL mode control devices:
                a) Operate valve when LOCAL-STOP-REMOTE integral to the actuator is in REMOTE and LOCAL-STOP-REMOTE on remote control station is in LOCAL.
                b) OPEN-STOP-CLOSE maintained switch or OPEN, STOP, and CLOSE pushbuttons where Maintained operation is indicated in the Actuator Schedule.
                c) OPEN-CLOSE spring-return switch or OPEN and CLOSE pushbuttons where momentary operation is indicated in the Attachment A - Actuator Schedule.

4) Pilots' lights to indicate valve position:
a) Fully open.
b) Fully closed.

4. Remote hand station:
a. Wall mounted.
b. Configuration: Bluetooth configuration tool.
c. Power: Via attached actuator (24 VDC output).

5. Control inputs:
a. Capable of using discrete 24 VDC.
b. Controls the valve when LOCAL-STOP-REMOTE is in REMOTE.
c. Isolated inputs capable of operating from external control voltage source or internal power supply:
d. Provide the following inputs:
1) OPEN.
2) CLOSE.
3) STOP.
e. OPEN and CLOSE inputs configurable between maintained (actuator runs until end of travel, high torque, or a STOP input) and momentary (actuator stops when command is removed).

6. Status outputs:
a. Monitor relay output: Dry contact, normally closed, opens when actuator is not in REMOTE or in the event of any internal fault or alarm condition.
b. Dry contact outputs configured for the functions indicated on the Drawings. Provide the following outputs for all actuators:
1) Fully closed.
2) Fully open.
3) LOCAL-STOP-REMOTE in REMOTE position.
c. Contacts and communications:
1) As specified in the Contract Documents.
2) Dry contacts rated for both 120 VAC and 24 VDC.
d. Analog input:
1) 4-20 mA analog input for analog modulating valves when indicated on the Drawings.
e. Analog output:
1) Isolated 4-20 mA analog output when indicated on the Drawings.
a) Loop power sourced from the actuator power supply.
b) Output proportional to process value(s) indicated on the Drawings.

E. Features:
1. Time delay on reversal: Incorporate time delay between stopping actuator and starting in opposite direction to limit excessive current, torque, and heating from instantaneous reversal.
2. Data logging:
a. Store diagnostic data and reference data.
b. Time-stamped historical operating data, including number of operations.
c. Starting torque, maximum running torque, and end of travel torque.
1) Store reference data (recorded during commissioning) and data from last operation.
3. Provide display of logged data on the actuator, or provisions to download to a personal computer.

F. Components:
1. Motors:
a. Specifically designed for valve actuator service with high starting torque, totally enclosed non-ventilated construction.
b. Torque ratings equal to or greater than that required for valve seating and dynamic torques with a 25 percent factor of safety.
1) Design requirements for rubber-seated AWWA butterfly valves:
a) Design actuators for maximum gate or valve operating torque, in accordance with and using safety factors required in AWWA C504 and AWWA C542.
(1) Valve actuator torque requirement for open-close service: Not less than the required valve-seating and dynamic torques under design operating conditions in accordance with AWWA C504.
(2) Valve actuator torque requirement for modulating service: Not less than twice the required valve dynamic torque under design operating conditions in accordance with AWWA C504.
2) Design requirements for slide gates, gate valves, knife gate valves, globe valves, and diaphragm valves:
a) Design valves and actuators for maximum operating torque in accordance with and using safety factors required in AWWA C542.
b) Design for the maximum torque and thrust running load over the full cycle.
c) Maximum torque or thrust rating: Actuator stall torque or maximum thrust output shall not exceed the torque or thrust capability of the valve or gate, as determined by the valve or gate manufacturer.
c. Capable of being removed and replaced without draining the actuator gear case.
d. Motor bearings shall be amply proportioned of the anti-friction type and permanently lubricated.
e. Rated for operating under the following conditions without exceeding temperature limits with ambient temperature of 40 degrees Celsius.
1) Continuous operation for 15 minutes or twice the open-to-close operating time (whichever is greater) at normal operating torque or 33 percent of maximum torque (whichever is greater).
2) 60 starts per hour for open/close service or 1,200 starts per hour for modulating service.
f. Provide the following motor protection features:
1) Jammed valve (no valve motion detected through a time delay).
2) High motor temperature (sensed by an embedded thermostats).
3) High torque.
4) Single phasing protection.

G. Position sensing:
1. Electronic and adjustable using a solid-state encoder wheel.
a. Mechanical limit switches and potentiometers are not acceptable.

2. Capable of retaining position and monitoring valve or gate motion when valve is manually actuated and when main power is not present.
3. Valve range and position switch outputs field adjustable.

H. Manual actuators:
1. Hand wheel for manual operation.
a. Maximum 80-pound pull on rim when operating gate or valve under maximum load.
b. Provide pull chain when motorized actuator is located more than 6 feet above floor surface.
1) Chain shall be of sufficient length to reach approximately 4 feet above the operating level.
2) Where the chain obstructs an aisle or walkway, provide holdback or other means to ensure chain does not create a nuisance or hazard to operating personnel.
3) Provide Type 316 stainless steel.
2. Declutch lever: Padlockable, capable of mechanically disengaging motor and related gearing and freeing hand wheel for manual operation.

I. Gearing: Hardened alloy steel spur or helical gears and self-locking, alloy bronze worm gear set.
1. Accurately cut to ensure minimum backlash.

J. Bearings:
1. Anti-friction bearing with caged balls or rollers throughout.
2. Sealed-for-life type thrust bearings housed in a separate thrust base.

K. Drive bushing:
1. Easily detachable for machining to suit the valve stem or gearbox input shaft.
2. Positioned in a detachable base of the actuator.

L. Lubrication:
1. Provide totally enclosed actuator gearing with oil or grease filled gear case suitable for operation at any angle.
2. Actuators requiring special or exotic lubricants are not acceptable.

2.05 ACCESSORIES

A. Software:
1. Furnish PC-based diagnostic and configuration software to display diagnostic data and configure actuators.
2. Provide software communications to the valve actuator and handheld setting tool using Bluetooth wireless or IrDA infrared communications.
a. Provide accessories and drivers required for operation and communications with a standard personal computer running Microsoft Windows.
b. Where infrared communications are used,furnish an IrDA to USB adapter with a mounting device to secure the infrared element to the valve actuator IrDA port:
1) Provide with a minimum cable length of 3 feet, capable of being extended with a standard USB extension cable.

B. Termination module cover:
   1. For actuators on a valve network, provide a means to keep the valve network in service, in the event where the actuator must be removed.
   2. Provide sunshades for outdoor installations of remote control stations that use an LCD or similar screen. Regular pushbutton, sector switches, and pilot light control stations will not require a sunshade.

2.06 SOURCE QUALITY CONTROL

A. Source Testing:
   1. Design and performance test reports in accordance with AWWA C542.
   2. Test each actuator with a simulated load.
      a. Simulate a typical valve load.
   3. Furnish test reports and the Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

B. Install the equipment in accordance with the manufacturer's instructions.

C. Position visual indicators so that they are most easily visible.

D. Installation Verification:
   1. Furnish Manufacturer's Certificate of Installation Verification.

3.02 FIELD QUALITY CONTROL

A. As specified in Section 01_75_17 - Commissioning, Section 46_05_94 - Mechanical Equipment Testing, and this Section.

B. Functional Testing:
   1. Installed actuator:
      a. Test witnessing: Witnessed.
      b. Conduct Level 1 General Equipment Performance Tests.
      c. Conduct Level 1 Vibration Tests.
      d. Conduct Level 1 Noise Tests.
   2. Electrical Instrumentation and Controls:
      a. Test witnessing: Witnessed.
      b. Conduct testing as specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.
   3. Furnish test reports and the Manufacturer's Certificate of Functional Compliance.

3.03 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations and Maintenance: 1.

3.04 ACTUATOR SCHEDULE

A. Provide actuators indicated on the Drawings:
   1. Major process actuators are listed in the Actuator Schedule shown in Attachment A - Actuator Schedule.
      a. Attachment A - Actuator Schedule does not include all number and types of actuators required for the Project.

END OF SECTION

ATTACHMENT A - ACTUATOR SCHEDULE

ACTUATOR SCHEDULE

Item	Reference DWG	Type	Size	Duty	NEMA Rating	Voltage/Phase/Hz	Notes	Service	Controls
WAS Pump 1 Discharge Valve, EDR-34033	050-M-105	PV	6”	STD	4X	480/3/60 Hz		O/C	D
WAS Pump 2 Discharge Valve, EDR 34034	050-M-105	PV	6”	STD	4X	480/3/60 Hz		O/C	D
TSL Sample Valve, EDR-53010	530-M-101	PV	2”	STD	4X	120/1/60 Hz		O/C	D
SST Bypass Valve, EDR-53014	530-M-101	PV	6”	STD	4X	480/3/60 Hz		O/C	D
SST Feed Valve, EDR-53015	530-M-101	PV	6”	STD	4X	480/3/60 Hz		O/C	D
SST Return Valve, EDR-53016	530-M-101	PV	6”	STD	4X	480/3/60 Hz		O/C	D

Notes:

(1) Provide actuators with remote control station.
(2) New motorized actuator to be installed on existing equipment. Field verify characteristics prior to sizing motor actuator.

Abbreviations:

Type:
BFV = Butterfly Valve.
BV = Ball Valve.
PV = Plug Valve.
SG = Slide Gate.

NEMA Rating:
4X for general locations.
6P for vaults and possible submergence.
XP for Class I, Division 1 and Division 2 locations.

Controls:
A = Analog.
D = Discrete.
DP = Profibus DP.
E-IP = Ethernet/IP.

Duty:
MD = Modulating duty (~1,200 starts/hr).
MOD = Modulating.
STD = Standard service (0-60 starts/hr) duty.

Service:
CTRL = Control.
O/C = Open/Close.

E-TCP = Ethernet TCP or TCP/IP.
FF = Foundation Fieldbus H1.
MB = Modbus RTU (RS-485).
NET = Manufacturer’s proprietary network.
PA = Profibus PA.

SECTION 40_05_62

PLUG VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Non-lubricated plug valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C517 - Resilient-Seated Cast Iron Eccentric Plug Valves.
   2. C606 - Grooved and Shouldered Joints.

B. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A536 - Standard Specification for Ductile Iron Castings.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures and Section 40_05_51.01 - Common Work Results for Valves.

B. Product data: As specified in Section 01_60_00 - Product Requirements.

C. Shop Drawings: Installation arrangement of major component assemblies.

D. Calculations.

E. Vendor operation and maintenance manual as specified in Section 01_78_24 - Operation and Maintenance Data.

F. Commissioning Submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning:
      a. Interior coating.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements and Section 40_05_51.01 - Common Work Results for Valves.

2.02 NON-LUBRICATED PLUG VALVES (PV00)

A. Manufacturers: One of the following or equal:
   1. Clow Valve.
   2. DeZurik, PEC.
   3. Milliken Valve, Model 600/601.

B. Application Schedule:
   1. Non-Sludge Lines.

C. Design:
   1. Type: Non-lubricated eccentric type, in accordance with AWWA C517.
   2. Plug face: Resilient material that operates satisfactorily at a temperature of 180 degrees Fahrenheit continuous and 215 degrees Fahrenheit intermittent, except for valves in compressed air or digester gas service.
      a. Valves in compressed air service: Resilient material suitable for continuous duty at 250 degrees Fahrenheit.
      b. Valves in digester gas service: Resilient material suitable for petroleum or digester gas at continuous duty at 180 degrees Fahrenheit.
   3. Compression washer: Provide flat compression washer made of Teflon™, or of a material having equal physical characteristics on valve stem between plug and bonnet.
   4. Stem seals: Provide stem seals serviceable without unbolting the valve bonnet assembly.
   5. Grit excluders: Provide PTFE grit excluders at upper plug journals to prevent entry of foreign solids in bearing area.
   6. Clearly mark valves to indicate their open and closed positions.
   7. Provide valves with ends as required by piping details indicated on the Drawings.
      a. Grooved end body valves:
         1) Usage: Plug valves with grooved ends may be used in piping systems specified in the Pipe Schedule to have grooved end joints and as indicated on the Drawings.
         2) Grooved end joint design: In accordance with AWWA C606.

D. Materials:
   1. Body and plug: ASTM A126, Class B, cast-iron or ASTM A536, Grade 65-45-12, ductile iron, with plug face of or Buna N material suitable for the intended service as specified under the “Design” article above.
   2. Body seats in valves 3-inch size and larger: Provide with overlay of not less than 90-percent nickel and minimum thickness of 1/8 inch on surfaces contacting the plug face.
   3. Stem bearing and bottom bearing: Type 316 stainless steel.

4. Internal parts, except the body and plug: Type 316 stainless steel.
5. Exposed nuts, bolts, and washers: Zinc plated. Exception: Exposed nuts, bolts, and washers for buried service: Stainless steel.

2.03 NON-LUBRICATED PLUG VALVES, FULL PORT (PV05)

A. Manufacturers: One of the following or equal:
1. Clow Valve.
2. DeZurik, PEF.
3. Milliken, 601F/600F.

A. Application Schedule:
1. Sludge Lines: BS, PS, and WAS pipelines.

B. Design:
1. Type: Non-lubricated eccentric type, in accordance with AWWA C517.
2. Plug face: Resilient material that operates satisfactorily at a temperature of 180 degrees Fahrenheit continuous and 215 degrees Fahrenheit intermittent, except for valves in compressed air or digester gas service.
3. Compression washer: Provide flat compression washer made of Teflon™, or of a material having equal physical characteristics on valve stem between plug and bonnet.
4. Stem seals: Provide stem seals serviceable without unbolting the valve bonnet assembly.
5. Grit excluders: Provide PTFE grit excluders at upper plug journals to prevent entry of foreign solids in bearing area.
6. Clearly mark valves to indicate their open and closed positions.
7. Provide valves with ends as required by piping details indicated on the Drawings.
    a. Grooved end body valves:
        1) Usage: Plug valves with grooved ends may be used in piping systems specified in the Pipe Schedule to have grooved end joints and as indicated on the Drawings.
        2) Grooved end joint design: In accordance with AWWA C606.

C. Materials:
1. Body and plug: ASTM A126, Class B, cast-iron or ASTM A536, Grade 65-45-12, ductile iron, with plug face of neoprene or Buna N material suitable for the intended service as specified under the “Design” article above.
2. Body seats in valves 3-inch size and larger: Provide with overlay of not less than 90-percent nickel and minimum thickness of 1/8 inch on surfaces contacting the plug face.
3. Stem bearing and bottom bearing: Type 316 stainless steel.
4. Internal parts, except the body and plug: Type 316 stainless steel.
5. Exposed nuts, bolts, and washers: Zinc plated. Exception: Exposed nuts, bolts, and washers for buried service: Stainless steel.

2.04 VALVE OPERATORS

A. Furnish valves with an operating wrench or worm gear operator:
1. Equip valves 4-inch nominal size and smaller with a lever operator.
2. Equip valves 6-inch nominal size and larger with a worm gear operator.

2.05 COATING

A. Coat and test interior metal surfaces as specified in Section 40_05_51.01 - Common Work Results for Valves.

B. Field applied coating of valve exterior:
   1. Match color and be compatible with the manufacturer's coating system and as specified in Section 09_96_01 - High-Performance Coatings.
      a. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
      b. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.06 SHIPMENT, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01_60_00 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves as specified in Section 40_05_51.01 - Common Work Results for Valves and the manufacturer's instructions.
   1. Unless otherwise indicated on the Drawings, install valves so that in the closed position the pressure in the pipeline applies a seating head on the valves.
   2. Install valves so that in the open position, the plug is located in the top half of the valve body.
   3. Furnish Manufacturer's Certificate of Installation Verification.

B. Valves requiring lubrication: Lubricate and fill extended lubricant pipes with lubricant suitable for service intended.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning and this Section.

B. Functional Testing:
   1. Tests: Witnessed.
   2. Conduct pressure and leak test as specified in Section 40_05_51.01 - Common Work Results for Valves.
   3. Furnish Manufacturer's Certificate of Functional Compliance.

END OF SECTION

SECTION 40_05_63

BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Ball valves.

B. As specified in Section 40_05_51.01 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.

B. American Water Works Association (AWWA):
   1. C507 - Standard for Ball Valves 6 Inch Through 48 Inch.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
   3. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_51.01 - Common Work Results for Valves:
   1. Metal body ball valves: 6 inches and larger only: Submit affidavit of compliance in accordance with AWWA C507.
   2. Operation and maintenance manual.

C. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. General: Unless otherwise indicated on the Drawings use:
   1. Metal body ball valves on metallic pipelines.
   2. Plastic body ball valves on plastic pipelines.

B. Do not use metal body ball valves in sodium hypochlorite or sodium bisulfite systems.

2.02 METAL BODY BALL VALVES - FULL PORT (BAV00)

A. Metal Body Ball Valves, 6-Inch Size and Larger:
   1. Manufacturers: One of the following or equal:
      a. Crane ChemPharma Energy.
      b. DeZURIK/APCO.
      c. Henry Pratt Company.
   2. General:
      a. Type: Non-lubricated, resilient seated or metal seated and capable of sealing in either flow direction.
      b. In accordance with AWWA C507.
      c. Stem packing: Manually adjustable while valve is under pressure.
      d. ASME B16.1, Class 125 flanged ends.
   3. Materials:
      a. Body: ASTM A48 cast iron with 400 series Monel seats (metal seated valves only) and integrally cast bronze bushed trunnions.
      b. Ball: Type 304 or 316 stainless steel.
      c. Seats:
         1) Resilient seated valves:
            a) Buna-N.
         2) Metal seated valves:
            a) 300 series stainless steel.
      d. Stem seals: PTFE or Viton™.
   4. Valve actuator:
      a. Manually operated valves: Self-locking worm gear type actuator with position indicator. Permanently lubricate gearing. Provide adjustable screws to stop travel at both open and closed positions.
      b. Electric motor operated valves: Provide electric motor operator as specified in Section 40_05_57.24 - Electric Actuators.

B. Metal body ball valves, less than 6-inch size
   1. Manufacturers: One of the following, or equal:
      a. Conbraco Industries, Inc., Apollo Valves.
      b. Flow-Tek, Inc.
      c. Metso Automation/Jamesbury.
      d. NIBCO, Inc.

2. General:
    a. Type: Non-lubricated, full port and capable of sealing in either direction.
    b. End connections:
        1) Threaded or solder ends for sizes 3-inch and smaller.
        2) Class 150 flanged for sizes larger than 3 inches.
            a) Flanges: In accordance with ASME B16.1 standards.
    c. Stem packing: Manually adjustable while valve is under pressure.
    d. Shafts:
        1) Rigidly connected to the ball by a positive means.
            a) Design connection to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
    e. Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
    f. Temperature limits: Suitable for operation between minus 20 and 350 degrees Fahrenheit.
3. Materials:
    a. Valves in copper lines: Bronze body.
    b. Valves in steel and ductile iron piping: Ductile iron or cast steel body.
    c. Valves in stainless steel piping: Stainless steel body, material type to match piping material as specified in Section 40_05_00.01 - Common Work Results for General Piping.
    d. Ball: Type 304 or 316 stainless steel, Type 316 in digester gas applications.
    e. Seats: PTFE.
    f. Stem seals: PTFE or Viton™.
    g. Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.
    h. Valves for combustible fluid applications (digester gas, natural gas, fuel oil, etc.) must be of fire safe design.
4. Venting requirements:
    a. Metal ball valves for hydrogen peroxide service:
        1) Provide valve with factory drilled 0.125-inch hole in the upstream side of the ball.
        2) Provide an engraved Type 316 stainless steel tag permanently attached to the valve stem stating, "One side of ball drilled for hydrogen peroxide service".

2.03 PLASTIC BODY BALL VALVES - FULL PORT (BAV40)

A. Manufacturers: One of the following or equal:
    1. Asahi America.
    2. Chemtrol Division, NIBCO, Inc.
    3. Georg Fischer Piping Systems.
    4. Hayward Flow Control.
        a. For sodium hypochlorite service, provide model TB-Z. Model TBH-Z shall not be used.
    5. IPEX USA, LLC
    6. Plast-O-Matic Valves, Inc.

B. General:
   1. Type: Non-lubricated and capable of sealing in either flow direction.
   2. End connections:
      a. 4 inches and smaller size: Socket end true unions for solvent welded connection to adjacent piping.
      b. 6-inch size: Socket end true unions with attached flanges for flanged connection to adjacent piping.
   3. All valves shall have integral ISO 5211 mounting pad for actuator installation.
   4. All valves shall have integral plate for lock-out/tag-out.
   5. Stem: Double o-ring seal with shear point above seal.
   6. Pressure rating: Suitable for the test pressure and maximum temperature of the corresponding piping system listed in the Piping Schedule.

C. Materials:
   1. Body and ball:
      a. PVC piping systems: PVC.
      b. CPVC piping systems: CPVC.
   2. Seats: PTFE (Teflon™).
   3. O-rings: Match gasket material of corresponding piping system listed in the Piping Schedule.

D. Limit switches, when indicated on the Drawings:
   1. Mechanical cam type with watertight enclosure and suited for remote indication of valve open-close status.
   2. Mount on valve actuator.
   3. Contacts: 120-volt alternating current, 20 amperes at 75 to 100 percent power factor and 24-volt direct current, 5 amperes minimum.

E. Valve actuator:
   1. Valves shall be quarter turn operated with valve seat adjustability.
   2. Manually operated valves: Lever.
      Electric motor operated valves, when indicated on the Drawings: Provide electric motor operator as specified in Section 40_05_57.24 - Electric Actuators.

F. Venting requirements:
   1. PVC and CPVC ball valves for hypochlorite service:
      a. Provide valve with factory drilled 0.125-inch hole in the upstream side of the ball.
      b. Provide an engraved plastic tag permanently attached to the valve stem stating, "One side of ball drilled for hypochlorite service".
      c. Provide an arrow inscribed on the valve body to indicate direction of flow.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test, as specified in Section 40_05_00.09 - Piping Systems Testing.

END OF SECTION

SECTION 40_05_64

BUTTERFLY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Butterfly valves:
      a. As specified in Section 40_05_51.01 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings, NPS 1/2 through NPS 24.

B. American Water Works Association (AWWA):
   1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
   2. C504 - Rubber-Seated Butterfly Valves.
   3. C540 - Standard for Power-Actuating Devices for Valves and Sluice Gates.
   4. C550 - Protective Interior Coatings for Valves & Hydrants.
   5. C606 - Standard for Grooved and Shouldered Joints.

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for Higher-Temperature Service.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   5. A395 - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
   6. A479 - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
   7. A515 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate - and Higher-Temperature Service.
   8. A516 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower-Temperature Service.
   9. A536 - Standard Specification for Ductile Iron Castings.
   10. A564 - Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
   11. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   12. A890 - Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application.

13. B462 - Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
14. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
15. B691 - Standard Specification for Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08366 and UNS N08367) Rod, Bar, and Wire.
16. D429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrate.

D. Compressed Gas Association (CGA):
   1. Standard G-4.1 - Cleaning Equipment for Oxygen Service.

E. NSF International (NSF):
   1. Standard 61 - Drinking Water System Components - Health Effects.

F. United States Code of Federal Regulations (CFR):
   1. 21 - Food and Drugs.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_51.01 - Common Work Results for Valves.
   1. For general purpose AWWA butterfly valves, include description of the method of attachment of the disc edge to the valve disc.
   2. Interior epoxy coatings: Affidavit of compliance attesting that epoxy coatings applied to interior surfaces of butterfly valves comply with all provisions in accordance with AWWA C550.
   3. Certification, for valves and coatings in contact with potable water, that the products used are suitable for contact with drinking water in accordance with NSF Standard 61.

C. Commissioning Submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
   1. Valve pressure rating shall be greater than or equal to the piping system test pressure specified in the Piping Schedule at the maximum service temperature.
   2. General purpose AWWA butterfly valves:
      a. Design standard: Provide valves designed and manufactured in accordance with AWWA C504.
      b. Class:
         1) Provide butterfly valves in accordance with AWWA Class 150B, unless otherwise specified.
         2) Provide butterfly valves in accordance with AWWA Class 250B in piping systems with test pressure greater than 150 pounds per square inch gauge and less than 250 pounds per square inch gauge.

B. Usage:
   1. Provide and install butterfly valve types as outlined in the Butterfly Valve Application Schedule at the end of this Section.

C. Design requirements for butterfly valves with power actuating devices:
   1. Design valves and actuators for maximum operating torque, in accordance with and using safety factors required in AWWA C540, using the following values:
      a. Maximum water velocity: 16 feet per second with valve fully open.
      b. Maximum pressure differential across the closed valve equal to the pressure class designation.
      c. Coefficient for seating and unseating torque, dynamic torque, and bearing friction in accordance with valve manufacturer's published recommendations.
   2. Valve disc: Seat in an angular position of 90 degrees to the pipe axis and rotate an angle of 90 degrees between fully open and fully closed positions:
      a. Do not supply valves with stops or lugs cast with or mechanically secured to the body of the valve for limiting the disc travel.
   3. Unacceptable thrust bearings: Do not provide valves with thrust bearings exposed to the fluid in the line and consisting of a metal bearing surface in rubbing contact with an opposing metal bearing surface.

D. Performance requirements:
   1. Tight shutoff at the pressure rating of the valve with pressure applied in either direction.
   2. Suitable for the following service conditions:
      a. Throttling.
      b. Frequent operation.
      c. Operation after long periods of inactivity.
      d. Installation in any position and flow in either direction.

2.02 GENERAL PURPOSE AWWA BUTTERFLY VALVES (BFV00)

A. Manufacturers: One of the following or equal:
   1. DeZURIK/Sartell Model BAW.
   2. Mueller/Pratt Co.

B. Valve body:
   1. Material: Cast iron, ASTM A126, Grade B, or ductile iron, ASTM A536, Grade 65-45-12.
   2. Body design:
      a. Flanged body valves:
         1) Usage: Comply with limitations specified in the Butterfly Valve Application Schedule.
         2) Flanges: In accordance with ASME B16.1 Class 125 flanges for Class 150B valves, in accordance with ASME B16.1 Class 250 flanges for Class 250B valves.
      b. Mechanical joint body valves:
         1) Usage: Comply with limitations specified in the Butterfly Valve Application Schedule.
         2) Mechanical joint design: In accordance with AWWA C110.
         3) When mechanical joint body valves are used, incorporate valve into thrust restraint analysis as specified in Section 40_05_19.01 - Ductile Iron Pipe: AWWA C151.
            a) Utilize test pressure on 1 side of valve and zero pressure on the opposite side of the valve.
            b) Restrain pipe joints on both sides of valve as determined by thrust analysis calculations.
      c. Grooved end body valves:
         1) Usage: Butterfly valves with grooved ends may be used in piping systems specified in the Piping Schedule to have grooved end joints. Comply with additional limitations specified in the Butterfly Valve Application Schedule.
         2) Grooved end joint design: In accordance with AWWA C606.

C. Disc:
   1. Material: Cast iron or ductile iron with Type 316 stainless steel edge that matches seat in valve body.
   2. Secure valve disc to shaft by means of smooth-sided, taper or dowel pins, Type 316 stainless steel, or Monel.
   3. Extend pins through shaft and mechanically secure in place.

D. Shaft and bearings:
   1. Shaft design:
      a. Valves 20-inches and less: 1-piece, through disc design.
      b. Valves greater than 20-inch size: 2-piece, stub shaft design.
   2. Shaft seal: Vee type, chevron design.
   3. Shaft material for Class 150B valves: Type 316 stainless steel, ASTM A276.
   4. Shaft material for Class 250B valves: Type 17-4 pH stainless steel, ASTM A564.

5. Shaft bearings: Self-lubricating sleeve type:
    a. Valves 20 inches and less: Nylatron.
    b. Valves greater than 20-inch size: Teflon™ with stainless steel or fiberglass backing.

E. Seats:
1. Seat materials:
    a. Match gasket material that is specified in the Piping Schedule for the specific piping system.
    b. Low-pressure air applications: EPDM.
    c. Digester gas applications: Teflon™.
    d. Natural gas applications: Buna N.
    e. Other applications: NBR or natural rubber.
2. For valves 20 inches in nominal size and smaller, bond or vulcanize seat into the valve body.
3. For valves 24 inches in nominal size and larger, retain seats mechanically or by adhesive:
    a. Mechanical retainage: Retain seat by a clamping ring with segmented clamping ring locks with adjusting locking screws.
        1) Clamping ring, ring locks, and adjusting locking screws: Type 316 stainless steel.
        2) Provide means to prevent ring locks and screws used to retain seats from loosening due to vibration or cavitation.
    b. Adhesive retainage: Inset the seat within a groove in the valve body and retain in place with epoxy injected behind the seat so that the seat expands into the body.
    c. Do not provide valves with seats retained by snap rings or spring-loaded retainer rings.
4. Resilient seat: Withstand 75 pounds per inch pull when tested in accordance with ASTM D429, Method B.

F. Valve packing:
1. Valves 4 to 48 inches nominal size: Self-adjusting V-type packing or chevron-type packing. NBR or EPDM to match seat material.
2. Valves 54 inches nominal size and larger: Adjustable V-type packing with bronze packing gland or self-adjusting V-type packing. NBR or EPDM to match seat material.

2.03 COATING REQUIREMENTS FOR METAL VALVES

A. Shop coat interior and exterior metal surfaces of valves, except as follows:
1. Interior machined surfaces.
2. Surfaces of gaskets and elastomeric seats and stem seals.
3. Bearing surfaces.
4. Stainless steel surfaces and components.

B. Coating material for components in contact with potable water applications:
   1. Formulate interior coating material from materials in accordance with CFR 21, AWWA C550, and NSF 61.
   2. Submit affidavit of compliance attesting that epoxy coatings applied to interior surfaces of butterfly valves in accordance with CFR 21, AWWA C550, and NSF 61.

C. Interior surfaces:
   1. Interior surfaces, except for valves used in low-pressure air service: High solids epoxy as specified in Section 09_96_01 - High-Performance Coatings, Attachment A - Coating Schedule.
   2. Interior surfaces of valves used in low-pressure air service: High temperature coating for range of 150 to 350 degrees Fahrenheit as specified in Section 09_96_01 - High-Performance Coatings, Attachment A - Coating Schedule.

D. Exterior surfaces:
   1. Exterior surfaces of valves, actuators, and accessories coating as specified in Section 09_96_01 - High-Performance Coatings, Attachment A - Coating Schedule for the following conditions:
      a. Other valves: High solids epoxy with polyurethane topcoat.
   2. Polished and machined surfaces: Apply rust-preventive compound,
      a. Manufacturers: One of the following or equal:
         1) Houghton, Rust Veto 344.
         2) Rust-Oleum, R-9.

E. Field applied coatings of valve exterior:
   1. Match color and be compatible with manufacturer's coating system and as specified in Section 09_96_01 - High-Performance Coatings.
      a. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
      b. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves with valve shafts horizontal, unless a vertical shaft is required to suit a particular installation, and unless a vertical shaft is indicated on the Drawings.

B. Install pipe spools or valve spacers in locations where butterfly valve disc travel may be impaired by adjacent pipe lining, pipe fittings, valves, or other equipment.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning, and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional Testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test, as specified in Section 40_05_51.01 - Common Work Results for Valves.

3.03 BUTTERFLY VALVE APPLICATION SCHEDULE

A. Acceptable butterfly valve types and body styles are listed in the Butterfly Valve Application Schedule provided at the end of this Section. Furnish and install butterfly valves in accordance with this Schedule.

Butterfly Valve Application Schedule	
Valve Type and Style	**Acceptable Applications**
General Purpose AWWA Butterfly Valves - Flanged Body Design	Aboveground or submerged in the following service applications only: • Acceptable in all service applications except oxygen and ozone service and high-pressure service. • May be used in buried applications when required by the specified piping system.
General Purpose AWWA Butterfly Valves - Mechanical Joint Body Design	Buried in the following service applications only: • Acceptable in all service applications except oxygen and ozone service and high-pressure service.
General Purpose AWWA Butterfly Valves - Lugged Body Design	Aboveground in the following service applications only: • Aeration Air Systems.
General Purpose AWWA Butterfly Valves - Wafer (not lugged) Body Design	Not allowed.
General Purpose AWWA Butterfly Valves - Grooved End Body Design	Aboveground, in sizes 20 inches and less, with piping system test pressure less than 100 psi, and in the following service applications only: • Acceptable in all service applications, except oxygen and ozone service, where piping for that service is specified in the Piping Schedule to have grooved end joints.

END OF SECTION

SECTION 40_05_65.01

GATE, GLOBE, AND ANGLE VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Gate, globe (non-pilot controlled), and needle valves.
   2. As specified in Section 40_05_51.01 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.
   2. B16.47 - Large Diameter Steel Flanges: NPS 26 through NPS 60, Metric/Inch Standard.

B. American Water Works Association (AWWA):
   1. C515 - Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Services.
   2. C550 - Protective Interior Coatings for Valves and Hydrants.

C. ASTM International (ASTM):
   1. B98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry:
   1. SP-81 - Stainless-Steel or Stainless-Steel-Lined, Bonnetless, Knife Gate Valves with Flanged Ends.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. As specified in Section 40_05_51.01 - Common Work Results for Valves.

C. Commissioning Submittals:
   1. For valves larger than 16 inches:
      a. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

B. Interior epoxy coatings: Affidavit of compliance attesting that epoxy coatings applied to interior surfaces of valves comply in accordance with all provisions of AWWA C550.

PART 2 PRODUCTS

2.01 GATE VALVES - GENERAL SERVICE (GV00)

A. Aboveground:
   1. Valves less than 3 inches in size for clean water and air service:
      a. Manufacturers: One of the following or equal:
         1) Crane, Figure 431.
         2) Jenkins, Figure 47.
         3) Lunkenheimer Co., Figure 2151.
      b. Design:
         1) Size and configuration: Indicated on the Drawings.
         2) Manufacturer's standard bronze, solid wedge disc, rising stem, screwed end, Class 150 pounds.
   2. Valves 3 inches in size and larger, single disk.
      a. Manufacturers: One of the following or equal:
         1) American Flow Control, Series 2500.
         2) M&H/Kennedy Valve Co.
         3) Mueller.
      b. Design:
         1) Size, material, configuration: Indicated on the Drawings.
         2) Resilient wedge type in accordance with AWWA C515.
         3) Flange, iron body, and bonnet rated for 200 pound working pressure.
            a) Provide O-ring seal between valve body and bonnet.
         4) Ductile or cast iron wedge encapsulated in nitrile rubber and capable of sealing in either flow direction.
         5) Bronze stem with double or triple O-ring or braided packing stem seals.
         6) Rising stem configuration with handwheel diameter sized to allow opening of valve with no more than a 40-pound pull.
         7) Coat interior and exterior surfaces of valve body and bonnet with fusion-bonded epoxy in accordance with AWWA C550.
   3. Valves 3 inches in size and larger, double disc:
      a. Flanged.
      b. Materials:
         1) 200 pound iron body.
         2) Bronze mounted.
      c. Configuration:
         1) Outside screw and yoke (OS&Y).
         2) Stems of silicon bronze in accordance with ASTM B98, Alloy No. C66100.

d. Inside configuration:
    1) Double disc; parallel seat.
    2) Handwheel.
e. Manufacturers: One of the following or equal:
    1) M&H Valve Co., Figure 68-02.
f. Design:
    1) Size, material, configuration: Indicated on the Drawings.

B. Underground:
1. Manufacturers: One of the following or equal:
    a. American Flow Control.
    b. M&H/Kennedy Valve Co.
    c. Mueller Co.
2. Design:
    a. Size, material, configuration: Indicated on the Drawings.
    b. Resilient wedge type in accordance with AWWA C515.
    c. Stem:
        1) Iron body, resilient seat, non-rising stem, double O-ring stem seal.
        2) Rising stem configuration with handwheel diameter sized to allow opening of valve with no more than a 40-pound pull.
    d. Ductile or cast iron wedge encapsulated in nitrile rubber and capable of sealing in either flow direction.
    e. Bronze stem with double or triple O-ring or braided packing stem seals.
    f. Coat interior and exterior surfaces of valve body and bonnet with fusion-bonded epoxy in accordance with AWWA C550.
    g. Valve operator: Provide standard AWWA 2-inch operating nut, matching valve key, and valve box for operating stem.

2.02 GATE VALVES - STEAM AND CONDENSATE SERVICE (GV20)

A. Valves 3 inches and smaller in size:
1. Manufacturers: One of the following or equal:
    a. Crane, No. 428.
    b. Jenkins, Figure 47U.
    c. Lunkenheimer Co., Figure 2127.
2. Design:
    a. Size and configuration: Indicated on the Drawings.
    b. Bronze, screwed, rising stem, solid wedge, screwed bonnet, suitable for service under pressures equal to and less than 125 pounds per square inch gauge, steam working pressure (SWP).

B. Valves larger than 3 inches in size:
1. Manufacturers: One of the following or equal:
    a. Crane No. 465-1/2.
    b. Jenkins, Figure 651C.
    c. Lunkenheimer Co., Figure 1430.
2. Design:
    a. Size and configuration: Indicated on the Drawings.
    b. Suitable for service under pressures equal to and less than 125 pounds per square inch gauge, steam working pressure (SWP), flanged, iron body, bronze mounted, solid wedge, outside screw and yoke (OS&Y).

2.03 KNIFE GATE VALVES (GV60)

A. Manufacturers: One of the following or equal:
   1. Non-AIS compliant valves:
      a. DeZURIK KGC series.
      b. ITT Fabri-Valve, Standard C37.
      c. Pentair, Figure PCS17.

B. Design:
   1. Size and configuration: Indicated on the Drawings.
   2. Suitable for service under pressures equal to and less than 150 pounds per square inch gauge.
   3. Full round port, metal or resilient seated, raised face design.
   4. Flanged wafer design drilled and tapped to ASME Class 125/150 standard. Face-to-face dimension shall meet MSS SP-81 for knife gate valves ASME B16.5 Class 150, 2 to 24 inches, or ASME 16.47 Series A Class 150, 26 to 48 inches.
   5. Rounded gate with beveled edge, finish-ground to 32 RMS, maximum, on both sides. Bottom edge shall have a beveled knife edge.
   6. Body to incorporate guides and jams to assist in seating.
   7. Packing shall consist of multiple layers of packing.
   8. Materials:
      a. Body: Cast or ductile iron or cast steel, with Type 316 stainless steel lining or cast Type 316 stainless steel or 2205 Duplex.
      b. Wetted components (including gate): Type 316 stainless steel or 2205 Duplex.
      c. Seat: Metal or NBR, EPDM, CR, Viton™.
      d. Yoke sleeve: Acid resisting bronze or aluminum bronze.
      e. Packing: PTFE.
      f. Packing gland: Match valve body material.
      g. Yoke: Type 304 stainless steel.
      h. Fasteners: Shall be stainless steel.
   9. Outside screw and yoke (OS&Y) with handwheel operator.

2.04 GLOBE VALVES - NON-PILOT-CONTROLLED (GLV00 AND GLV20)

A. General (GLV00):
   1. Valves 3 inches and smaller:
      a. Manufacturers: One of the following or equal:
         1) Except in welded steel piping:
            a) Crane, No. 1 Globe or No. 2 Angle.
            b) Lunkenheimer Co. Figure No. 2140 Globe or No. 2141 Angle.
         2) In welded steel piping:
            a) Crane, No. 351.
            b) Lunkenheimer Co., Figure No. 1123; or equal with flanged ends.
      b. Design:
         1) Size and configuration: Indicated on the Drawings.
         2) Valve: Class 125 threaded ends, rated for 250 degrees Fahrenheit at pressure of 170 pounds per square inch.

2. Valves larger than 3 inches:
    a. Manufacturers: One of the following or equal:
        1) Crane, No. 351.
        2) Lunkenheimer Co., Figure No. 1123.
    b. Design:
        1) Size and configuration: Indicated on the Drawings.

B. Plug disc type for throttling or severe service (GLV20):
1. Manufacturers: One of the following or equal:
    a. Crane, No. 212P or No. 384P.
    b. Lunkenheimer Co., 72-PS or 73-PS1.
2. Design:
    a. Size and configuration: Indicated on the Drawings.
        1) Material: Iron body stainless steel trimmed plug type seat and disc.

C. Hose valves:
1. Manufacturers:
    a. Globe threaded valve: One of the following or equal:
        1) Crane, No. 7TF.
        2) Stockham, Figure No. B22T.
    b. Angle threaded valve: One of the following or equal:
        1) Crane, No. 17TF.
        2) Stockham, Figure No. B222T.
2. Design:
    a. Size and configuration: Indicated on the Drawings.
    b. Valve: Globe or angle valve with threaded ends.
    c. Disc: Renewable, made of Teflon™ or Buna-N.
    d. Threaded ends rated for a pressure of 200 pounds per square inch.

D. Yard hydrants:
1. Freezeless yard hydrant:
    a. Manufacturers: One of the following or equal:
        1) Kupferle Foundry Co.
            a) #1 Total Eclipse Yard Hydrant - 3/4 inch and 1 inch.
        2) Murdock Company:
            a) #M-75 - 3/4 inch or #M100 - 1 inch.
        3) Zurn Company:
            a) #1385 - 3/4 inch or 1 inch.
    b. Design:
        1) Self-draining, non-freezing, compression type.
            a) Inlet connection size: Indicated on the Drawings.
            b) Outlet connection size: Indicated on the Drawings.
            c) Materials:
                (1) Exterior casing pipe material: Indicated on the Drawings.
                (2) Interior operating rod material: Indicated on the Drawings.
                (3) Casing guard material: Indicated on the Drawings.
                (4) Principal interior operating parts material: Brass and/or bronze and removable from yard hydrant for servicing without excavation.
            d) Provide 4 spoke, ball wheel handle operated.

2. Freezeless post hydrants (HYD01):
    a. Manufacturers: The following or equal:
        1) Kupferle Foundry Co.:
            a) #2 Eclipse Post Hydrant.
        2) Mueller Co.:
            a) #A-411 Post Hydrant.
        3) Murdock Co.:
            a) #M-200 Post Hydrant.
    b. Design:
        1) Self-draining, non-freezing, compression type with a 2-3/16-inch valve opening.
        2) Inlet connection size: Indicated on the Drawings.
        3) Outlet connection size: Indicated on the Drawings.
        4) Materials:
            a) Exterior casing pipe material: Indicated on the Drawings.
            b) Interior operating rod material: Indicated on the Drawings.
            c) Top stock material: Indicated on the Drawings.
            d) Principal interior operating parts material: Brass and/or bronze and removable from hydrant for servicing without excavation.
        5) Provide 1-1/2-inch pentagon operating nut operated by a hydrant wrench or 10-inch handwheel:
            a) Manufacturers: The following or equal:
                (1) Kupferle Foundry Co.

2.05 NEEDLE VALVES (NV00)

A. Manufacturers: One of the following or equal:
    1. Crane No. 88 or No. 89.
    2. Lunkenheimer Co., Figure No. 906-BS or No. 907-BS.
    3. Powell, Figure No. 180.

B. Design:
    1. Size and configuration: Indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount yard hydrants on minimum 1-inch supply pipe or size indicated on the Drawings.

B. Mount post hydrants on minimum 2-inch supply pipe or size indicated on the Drawings.

C. Set yard and post hydrants in 4 cubic feet of 3/4 inch minimum crushed stone surrounding valve body to allow for proper drainage.
    1. Install in accordance with AWWA recommendations for hydrants.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning and this Section.

B. Manufacturer services: For valves larger than 16 inches.
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional Testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 40_05_51.01 - Common Work Results for Valves.

END OF SECTION

SECTION 40_05_65.24

CHECK VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. General swing check valves.
   2. Angled Disc Rubber Flapper check valves:

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

B. American Water Works Association (AWWA):
   1. C508 - Standard for Swing-Check Valves for Waterworks Service 2 Inch Through 24 Inch NPS.

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A213 - Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A313 - Standard Specification for Stainless Steel Spring Wire.
   5. A536 - Standard Specification for Ductile Iron Castings.
   6. A582 - Standard Specification for Free-Machining Stainless Steel Bars.
   7. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   8. B16 - Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
   9. B61 - Standard Specification for Steam or Valve Bronze Casting.
   10. B62 - Standard Specification for Composition Bronze or Q=Ounce Metal Castings.
   11. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

D. National Electrical Manufacturers Association (NEMA).

E. NSF International (NSF):
   1. 61 - Drinking Water Components Health Effects.
   2. 372 - Drinking Water System Components - Lead Content.

F. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. As specified in Section 01_60_00 - Product Requirements.

C. Quality Control Submittals
   1. Provide Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements and Section 40_05_51.01 - Common Work Results for Valves.

B. Provide check valves as shown on the Check Valve Schedule and suitable for service:
   1. In either horizontal or vertical position.
   2. For working pressures up to 150 pounds per square inch.

C. Check valve materials as follows unless otherwise specified.
   1. Cast iron in accordance with ASTM A126, Grade B.
   2. Ductile iron in accordance with ASTM A536, Grade 65-45-12.
   3. Type 303 stainless steel in accordance with ASTM A582 (UNS S30300).
   4. Type 316 stainless steel in accordance with ASTM A313.

D. Flanges: Drilled in accordance with ASME B16.1 Class 125/150, unless otherwise specified or indicated on the Drawings.

2.02 GENERAL SWING CHECK VALVES (CKV00)

A. Valves 1/4 inch through 3 inches:
   1. Manufacturers: One of the following or equal:
      a. Crane Valve Co., Number 36.
      b. Lunkenheimer Co., Figure 554Y.
   2. Design:
      a. Y-pattern body with integral seat.
      b. Female threaded ends.
      c. Renewable hinged disc.
      d. Threaded cap for access to valve seat without disassembly of piping.
      e. Integral seats suitable for regrinding.
   3. Materials:
      a. Body: Bronze in accordance with ASTM B62-83600.

b. Disc: Bronze in accordance with ASTM B62 C92200.
    1) On valves less than 1-inch: Brass in accordance with ASTM B16.
c. Hinge: Bronze in accordance with ASTM B584 C 87600.
d. Lock nut and hinge pin plug: Brass in accordance with ASTM B16 HO2.
e. Hinge pin: Stainless steel in accordance with ASTM A276.
f. Cap: Bronze in accordance with ASTM B61 C92200.
g. If used for steam service:
    1) Body and disc: S1 steam bronze in accordance with ASTM B61.

B. Valves 4 inches through 24 inches:
1. Manufacturers: One of the following or equal:
    a. APCO Model 250.
    b. Crispin SWL Series.
    c. Kennedy, Figure 106LW or M&H, Model 159.
    d. Mueller Co., Model A-2600.
2. Design:
    a. In accordance with AWWA C508.
    b. Constructed to permit top entry and removal of internal components without removing the valve.
    c. Equipped with outside lever and weight.
        1) Provide outside lever and spring for RAS pump swing check valves.
3. Materials:
    a. Body: Cast iron, ASTM A126, Class B, or ASTM A536, Grade 65-45-12 ductile iron.
    b. Disc:
        1) Valve disc shall be ASTM A126 cast iron, ASTM A536 ductile iron, or ASTM B584 bronze.
        2) 4-inch valves: Bronze or stainless steel rings and seats.
        3) 6 inches and larger valves: Bronze-faced or stainless steel rings and seats.
        4) Rubber seat Buna-N or EPDM.
    c. Hinge pins: Stainless steel.

2.03 ANGLED DISC RUBBER FLAPPER CHECK VALVE (CKV03)

A. Manufacturers: One of the following or equal:
1. GA, Slaminator.
2. Val-Matic Surgebuster Series #7200.

B. Design:
1. Designed, manufactured, and tested in accordance with American Water Works Association Standards AWWA C508.
2. Valves used in potable water service shall be certified to NSF 61 Drinking Water System Components - Health Effects, and certified to be lead-free in accordance with NSF 372.
3. Provided with flanges in accordance with ASME B16.1, Class 125.

4. Valve body shall be full flow equal to nominal pipe diameter at all points through the valve.
    a. Seating surface: 45-degree angle to minimize disc travel.
    b. Threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator or oil cushion device without special tools or removing the valve from the line.
5. Top access port shall be full size, allowing removal of the disc without removing the valve from the line.
    a. Access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content.
    b. Threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.
    c. Disc: 1-piece construction, precision molded with an integral O-ring type sealing surface, and reinforced with alloy steel.
    d. Flex portion of the disc shall contain nylon reinforcement and shall be warranted for 25 years.
    e. Non-slam closing characteristics shall be provided through a short 35-degree disc stroke and a disc accelerator to provide a cracking pressure of 0.3 psig.
6. Disc accelerator: 1-piece construction, rapid closure of the valve in high head applications.
    a. Enclosed within the valve, field adjustable and replaceable without removal of the valve from the line.
    b. Securely held in place by being captured between the cover and disc.
    c. It shall be formed with a large radius to allow smooth movement over the disc surface.

C. Materials:
1. Body and cover:
    a. Less than 30 inches: ASTM A536, Grade 65-45-12 ductile iron.
    b. 30 inches and larger: ASTM A126, Class B.
    c. Grade CF8M stainless steel for sizes 3 inches through 12 inches.
2. Disc: Precision molded Buna-N (NBR).
3. Disc accelerator: Type 302 stainless steel.
4. Materials for sludge (abrasive) service for BS, PS, and WAS pipes:
    a. Glass lining.
5. Coating: Exterior and interior of the valve shall be coated with an NSF 61 approved fusion bonded epoxy coating.

D. Quality assurance:
1. Manufacturer shall demonstrate a minimum 5 years of experience in the manufacture of resilient, flexible disc check valves.
2. Valve disc shall be cycle tested 1,000,000 times in accordance with AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. Test results shall be independently certified.
3. Valves shall be hydrostatically tested and seat tested to demonstrate zero leakage. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.

2.04 CENTER GUIDE (SILENT) CHECK VALVES (CKV60)

A. Manufacturers: One of the following or equal:
   1. APCO, CSC 600A.
   2. Crispin, GC Series.

B. Design:
   1. Center-guided, spring-loaded plug.
   2. Replaceable seat and plug.
   3. Shaft guide bushing.
   4. Non-slam, silent shutoff.
   5. Flanged body.

C. Materials:
   1. Body: Cast iron, ASTM A126, Grade B ductile iron, ASTM A536, Grade 65-45-12, or stainless steel, ASTM A743, Grade CF8M.
   2. Plug and seat: Stainless steel, ASTM A743, Type 316.
   3. Spring: Stainless steel, ASTM A313, Type 316.
   4. Shaft and bushing: Stainless steel, ASTM A213, Type 316.
   5. Seat ring: Buna-N or Viton.

D. Certified hydrostatic shell and seat test report.
   1. Only for valves larger than 16 inch.

2.05 PLASTIC BALL CHECK VALVES (CKV65)

A. Manufacturers: One of the following or equal:
   1. Georg Fischer Piping Systems.
   2. Hayward Flow Control.
   3. Nibco, Chemtrol Series.
   4. Plast-O-Matic.

B. Design:
   1. Ball type design.
   2. Materials: As specified in the Check Valve Schedule.
   3. Inlet pressure rating:
      a. PVC, CPVC, or PVDF: 150 pounds per square inch at 77 degrees Fahrenheit.
      b. PP: 100 pounds per square inch at 77 degrees Fahrenheit.

2.06 INTERIOR PROTECTIVE LININGS

A. As shown in the valve schedules and as specified in Section 40_05_51.01 - Common Work Results for Valves.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flapper-type check valves:
   1. Install with proper orientation of flow direction arrow on valve body or as indicated in the manufacturer's recommendation (instruction).
   2. When installed in horizontal pipelines, mount with shaft on vertical locations.
   3. When mounted in a vertical pipeline, directly downstream of an elbow, mount with the shaft perpendicular to the outermost portion of the elbow.
   4. Mount on downstream side of discharge silencer when used on positive displacement and centrifugal blowers.

B. Thermoplastic swing check valves:
   1. Install with proper orientation of flow direction arrow on valve body.
   2. Installation in a vertical pipeline shall only be allowed where pressurized flow direction is up, through the valve. Vertical installation in lines where pressurized flow direction is down shall not be allowed.

3.02 FIELD QUALITY CONTROL

A. Manufacturer services:
   1. Provide the Manufacturer's Certificate of Installation Verification.

B. Functional Testing:
   1. Test witnessing: Witnessed.
   2. Conduct pressure and leak test, as specified in Section 40_05_00.09 - Piping Systems Testing.

END OF SECTION

SECTION 40_05_67.40

AIR AND VACUUM RELIEF VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Air release valves, air and vacuum valves, and air vents.

B. As specified in Section 40_05_51.01 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.

B. American Water Works Association (AWWA).

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   3. A270 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing.
   4. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data: As specified in Section 40_05_51.01 - Common Work Results for Valves.

C. Commissioning Submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bond.

PART 2 PRODUCTS

2.01 METAL BODY AIR RELEASE VALVES - SEWAGE SERVICE (ARV20)

A. Manufacturers: One of the following or equal:
   1. Multiplex Manufacturing Co., Crispin Series S.
   2. Valve and Primer Corp., DeZURIK/APCO, Series 400.

B. Design:
   1. Operation: Release accumulated air in sewage pipelines operating under pressure. After entrained air escapes through the orifice, the orifice is plugged by a needle mounted on a compound lever mechanism.
   2. Internal components removable through top cover without removing valve from pipeline.
   3. Pressure rating: 150 pounds per square inch.
   4. Provide low pressure seat when the operating pressure is below 10 psi.
   5. Orifice size: 1/4-inch diameter.
   6. Connections: 2-inch threaded inlet and 1/2-inch threaded outlet.

C. Accessories:
   1. Inlet shutoff valve. Utilize eccentric plug valve.
   2. 2 blowoff valves for backflushing.
   3. 10 feet of hose with quick disconnect couplings.

D. Materials:
   1. Body: Cast iron or ductile iron.
   2. Float: Type 316 stainless steel.
   3. Needle: Buna-N.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 40_05_51.01 - Common Work Results for Valves and the manufacturer’s instructions.

B. Install air release valves and air and vacuum valves with suitable discharge lines to nearest drainage system.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Installation and Functionality Compliance.

C. Functional Testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 40_05_51.01 - Common Work Results for Valves.

END OF SECTION

SECTION 40_41_00

PROCESS PIPING AND EQUIPMENT HEAT TRACING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Heat tracing cable for outdoor water and chemical piping including the following:
   1. Heating cables.
   2. Control panels.
   3. Temperature sensors.
   4. Temperature controllers.
   5. Contactors.
   6. Enclosures.
   7. All other auxiliary equipment and controls required to complete a heat tracing system.

1.02 REFERENCES

A. National Electrical Manufacturers' Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

B. Underwriters' Laboratories, Inc.(UL):
   1. 746B - Polymeric Materials - Long Term Property Evaluations.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Catalog number, wattage output, voltage rating, and product data.
   2. Wiring diagrams and power distribution plan.
   3. Installation Instructions.
   4. Warranty.

C. Shop drawings: Include isometric drawings for each heat traced pipe showing installation details, and size and type of heat tracing cable.

1.04 QUALITY ASSURANCE

A. Regulatory requirements and reference standards:
   1. The electric heat tracing system shall be as specified in this Section and shall be designed, manufactured, and tested in accordance with the minimum applicable requirements of the latest edition of the following codes and standards.
   2. Additional specific requirements shall be further defined in the testing requirements for each Section.

1.05 WARRANTY

A. Cables: All cables shall be warranted for a period of 10 years for manufacturing defects.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. General: Heat tracing applications up to a maintain temperature of 250 degrees Fahrenheit and intermittent exposure to 420 degrees Fahrenheit shall use self-regulating heating cables and pads.

B. Self-regulating heating cable shall vary its heat output relative to the temperature of the surface of the pipe or the tank allowing cable to be crossed over itself without overheating and to be cut to length in the field.

C. Design for a useful life of 20 years or more with "power on" continuously.
   1. The criteria for life shall be to retain at least 75 percent of its original power when tested according to UL 746B.

D. Pipe shall be heat traced and insulated in accordance with Section 40_05_06.55 - Piping Insulation to maintain an operating temperature of 75 degrees Fahrenheit for a minimum ambient temperature of 32 degrees Fahrenheit.

E. Heat trace system controller:
   1. Provided with a single power source, as described below.
   2. Provide all necessary components for heat tracing all of the piping [as specified in Section 40_05_00.01 - Common Work Results for General Piping and/or as indicated on the Drawings.
   3. A limited number of electrical conduits are as indicated on the Drawings as a guide for the Contractor.
   4. Contractor shall determine the quantities for all components including electrical conduit, conductors, and the sizes of the breakers for this particular application as required and recommended by manufacturer, subject to Engineer acceptance, for a complete operable system at no additional cost to the Owner.
   5. Provide: Power connecting kits with junction boxes.
   6. End seal kits.
   7. Fittings kits.
   8. Electric traced labels.
   9. Aluminum tapes.
   10. Line sensing thermostats:
      a. Contactor.

2.02 HEAT TRACING CABLE

A. Manufacturers: One of the following or equal:
   1. Raychem, BTV.
   2. Chromalox, Type SRL Rapid Trace.
   3. Eaton Corp., equivalent product.
   4. Dekoron, equivalent product.

B. Type: Self-regulating and self-limiting, 5 watts per foot (W2 and W3) or 9 watts per foot (BS), 120 volts, 60 hertz, flexible twin 16 American Wire Gauge copper bus wires, with tinned copper braid overshield.
   1. Provide wattage of cable suitable for maintaining specified temperature at the minimum site ambient temperature for the pipe size and insulation as indicated on the Drawings.

2.03 CONTROLLER

A. Manufacturers: The following or equal:
   1. Raychem, Elexant 4010i.

B. Operating characteristics:
   1. Controller shall provide continuous monitoring of heat tracing circuit analyzing temperature through a hard-wired RTD.
   2. Controller shall energize system automatically if the temperature drops below a preset point.
      a. Controller shall be equipped with local alarm to alert maintenance personnel if heat trace circuit is interrupted. Provisions to monitor local alarm remotely:
         1) Form-C Dry contact rated 100-277 VAC, 3 Amp, 60 Hz.
   3. Controller shall have the capability of performing a self-diagnostic check on the system and advising maintenance personnel of the exact nature of any circuit problems.

C. Controller shall be fully compatible with heat trace and provided by same manufacturer as heat trace.
   1. One single 208-volt 3-phase power source will be provided to the heat tracing control system panel as indicated on the Drawings:
      a. Provide any required transformers for any secondary voltages.
      b. Provide a configurable dry contact for heat trace fault.
   2. Controller shall have double pole solid-state switching, temperature control from -40 degrees Fahrenheit to 125 degrees Fahrenheit, and a 30-amp rating from -40 degrees Fahrenheit to 125 degrees Fahrenheit ambient temperature.
   3. Power supply: Provide controller power supply with adjustable ground fault detection.
   4. Controller shall have battery backup system to retain programmed parameters in the event of a power failure.
   5. Enclosure: Unit shall be enclosed in a NEMA Type 4X stainless steel panel.

6. Network capabilities: Controller shall have network capabilities enabling monitoring and programming from a central location.
    a. MODBUS RTU and MODBUS TCP/IP.
7. Heat trace controller listed for Hazardous Location use Class I, Division 2, Group D.

2.04 CONNECTION KITS, END SEALS, SPLICE AND TEE KITS

A. Heat trace connection, end, splice, and tee kits shall be designed to meet or exceed the life of the heat trace and shall be given equal consideration and evaluation.

B. Provide wiring, conduits, junction boxes, and any other electrical components as required.

2.05 ACCESSORIES

A. Power connection kits.

B. Termination kits.

C. Splice kits.

D. End seal kits.

E. Straps.

F. Thermostat.

G. Contactor.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install heat tracing cable on water pipes:
    1. Heat tracing cable for outdoor aboveground water (W1 and W3) and blended sludge (BS) in Area 440.

B. Wrap heat-tracing tape with aluminum tape prior to installing insulation.

C. Install pipe insulation as specified in Section 40_05_06.55 - Piping Insulation.

D. Install heat tape and controls in accordance with manufacturer's published installation instructions.

E. Thermostats will be connected to the Heat Trace Controller/control panel. The location of the thermostat(s) shall be as follows:
    1. Area 440 W3 Piping:
        a. At the base of the W3 pipe near ground level on southeast corner of sludge storage tank (for water feed to top of tank).

2. Area 440 W2 Piping
    a. Near base of the W2 pipe feeding the odor control makeup water system.
3. Area 440 BS Piping
    a. Near base of the BS pipe near ground level on south side of sludge storage tank.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's field service:
    1. Inspect installed systems for proper installation.
    2. Instruct Owner's personnel on operations and maintenance of the systems.

END OF SECTION

SECTION 40_61_00

COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Process control and instrumentation systems requirements for common components including installation, including, but not limited to, the following:
      a. Hardware.
      b. Software.
      c. Programming.
      d. Testing.
      e. Commissioning.
   2. Loop drawings:
      a. Provide complete loop drawings for all systems, including packaged equipment furnished as part of a vendor furnished package, and pre-purchased equipment.
      b. The form, minimum level of detail, and format for the loop drawings must match that of the sample loop drawings included in the Contract Documents.
      c. Owner and Engineer are not responsible for providing detailed loop diagrams for Contractor furnished equipment.
   3. Requirements of the Instrumentation and Control Specifications apply to all Instrumentation and Control Work specified in Technical Sections, including packaged mechanical systems, LCPs, VCPs, etc.

B. Contract Drawings:
   1. Schematic diagrams:
      a. Use schematic diagrams in conjunction with the descriptive operating sequence in the Technical Sections to furnish a coordinated and fully functional control system.
      b. Schematic diagrams show control function only.
         1) Incorporate other necessary functions for proper operation and protection of the system.
      c. Controls are indicated on the Drawings as de-energized.
      d. Add relays, where required, to provide necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
      e. Mount devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated on the Drawings.

1.02 REFERENCES

A. Abbreviations:
   1. ACB: Automatic current balance.
   2. ATS: Automatic Transfer Switch.
   3. CCS: The PCS central computer system (CCS) consisting of computers and software. The personal computer-based hardware and software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software and functions.
   4. DPDT: Double-pole, double-throw.
   5. ECP: Electronic circuit protector.
   6. ES: Ethernet Switch.
   7. FAT: Factory acceptance test also known as Source Test.
   8. HART: Highway addressable remote transducer.
   9. HMI: Human machine interface is a software application that presents information to an operator or user about the state of a process, and to accept and implement the operators control instructions. Typically, information is displayed in a graphical format.
   10. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode, equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode, equipment is started or stopped, and valves are opened or closed through a control algorithm within the PLC software. In the Off mode, the equipment is prohibited from responding from the PLC control.
   11. I/O: Input/Output.
   12. ICSC: Instrumentation and control system contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
   13. IJB: Instrument junction boxes: A panel designed with cord sets to easily remove, replace, or relocate instrument signals.
   14. IP: Internet protocol or ingress protection.
   15. LAN: Local area network: A control or communications network that is limited to the physical boundaries of the facility.
   16. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
   17. LOI: Local Operator Interface is an operator interface device consisting of an alphanumeric or graphic display with operator input functionality. The LOI is typically a flat panel type of display mounted on the front of an enclosure with either a touch screen or tactile button interface.
   18. LOR: Local-Off-Remote control function. In the Remote mode, equipment is started or stopped, and valves are opened or closed through the PLC based upon the selection of the HOA. In the Local mode, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.

19. NJB: Network junction box. An enclosure that contains multiple access points to various networks within the facility. Networks could be Ethernet, Ethernet/IP, Fieldbus, RIO, etc.
20. P&ID: Process and instrumentation diagram.
21. PC: Personal computer.
22. PCIS: Process control and instrumentation system: Includes the entire instrumentation system, the entire control system, and all of the Work specified in the Instrumentation and Control Specifications and depicted on the Instrumentation Drawings. This includes all the PCS and instruments and networking components as well as the various servers, workstations, thin clients, etc.
23. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
24. PCS: Process Control System: A general name for the computerized system that gathers and processes data from equipment and sensors and applies operational controls to the process equipment. It includes the PLCs and/or RIOs, LOIs, HMIs, both LCPs, VCPs and all data management systems accessible to staff.
25. PJB: Power junction box: An enclosure with terminal blocks that distribute power to multiple instruments.
26. PLC: Programmable logic controller.
27. PS: Power supply.
28. RIO: Remote I/O device for the PLC consisting of remote I/O racks or remote I/O blocks.
29. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
30. SCADA: Supervisory control and data acquisition system: A general name for the computerized system that gathers and processes data from sensors and equipment located outside of the facility, such as wells, lift stations, metering stations, etc.
31. SELV: Safety extra-low voltage.
32. SFP: Small form-factor pluggable.
33. SPDT: Single-pole, double-throw.
34. SPST: Single-pole, single-throw.
35. UPS: Uninterruptible power supply.
36. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, LOI, HMI, etc.
37. WAN: Wide area network: A control or communications network that extends beyond the physical boundaries of the facility.

B. Standards:
   1. American Petroleum Institute (API):
      a. RP 550 - Manual on Installation of Refinery Instruments and Control Systems; Part II-Process Stream Analyzers; Section 5-Oxygen Analyzers.
      b. RP 551 - Process Measurement Instrumentation.
   2. International Organization for Standardization (ISO):
      a. 9001 - Quality Management Systems - Requirements.
   3. International Society of Automation (ISA):
      a. 5.1 - Instrumentation Symbols and Identification.

b. 5.4 - Instrument Loop Diagrams.
c. 20 Instrument Forms Plus Pro-Combo-Enterprise Version (Microsoft SQL Server Express Database Software based).

4. National Electrical Manufacturers Association (NEMA).
5. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code (NEC).
6. National Institute of Standards and Technology (NIST).
7. Underwriters Laboratories, Inc. (UL):
   a. 508 - Standard of Safety for Industrial Control Equipment.
   b. 508A - Standard of Safety for Industrial Control Panels.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. 2-Wire transmitter (loop powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Section, 2-wire transmitter refers to a transmitter that provides a signal such as 4 to 20 mA 24 VDC regulation of a signal in a series circuit with an external 24 VDC driving potential:
      a. Fieldbus communications signal or both.
   2. Control circuit: Any circuit operating at 120 volts alternating current (VAC) or direct current (VDC) or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
   3. Digital bus: A communication network, such as PROFIBUS, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions, and diagnostic information.
   4. Instrument: A measurement device that includes a sensor for taking the measurement and one or both of the following:
      a. A local display.
      b. A device for communicating the measurement to a remote location such as a PLC or DCS.
   5. Modifications: Changing, extending, interfacing to, removing, or altering an existing circuit.
   6. Panel: An instrument support system that may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems.
   7. Power circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
   8. Powered transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Section, the produced signal may be a 4 to 20 mA 24 VDC signal, a digital bus communications signal, or both.
   9. Programmer: Responsible for PLC programming and SCADA/HMI software configuration.
   10. RS-485: RS-485 is also known as TIA-485 or EIA-485, is a standard defining the electrical characteristics of drivers and receivers for use in serial communications system. Electrical signaling is balanced, and multipoint

systems are supported, can be used with data rates up to 10 Mbit/s or at lower speeds distances up to 1,000 meters (4,000 feet).

11. Signal circuit: Any circuit operating at less than 50 VAC or VDC, which conveys analog information or digital communications information.

1.04 DELEGATED DESIGN

A. The requirements for Delegated Design are specified in the Technical Sections.

1.05 SUBMITTALS

A. General:
   1. Adhere to the wiring numbering scheme as specified in Section 26_05_53 - Identification for Electrical Systems throughout the Project:
      a. Uniquely number each wire.
      b. Wire numbers must appear on Equipment Drawings.
   2. Some items of Work are represented schematically, and are designated for the most part by numbers, as derived from criteria in ISA-5.1:
      a. Employ the nomenclature and numbers designated in this Section and indicated on the Drawings exclusively throughout Shop Drawings, datasheets, and similar Submittals.
      b. Replace any other symbols, designations, and nomenclature unique to a manufacturer's, Supplier's, or Subcontractor's standard methods with those identified in this Section and indicated on the Drawings.

B. Specific Submittal requirements:
   1. Control Panel Drawings:
      a. General Requirements:
         1) Submit panel, enclosure, console, furniture, and cabinet layout drawings for all items provided.
         2) Use equipment and instrument tags as depicted on the P&IDs for all Submittals.
         3) Nameplates and Wire Labeling:
            a) Nameplate legend including text, letter size, materials, and colors.
            b) As specified in Section 26_05_53 - Identification for Electrical Systems or as indicated on the Drawings.
         4) Structural Requirements:
            a) Anchoring method and leveling criteria, including manufacturer's recommendations for the Project site seismic criteria.
            b) Weight.
         5) Clearly show modifications to existing circuits:
            a) Show existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
      b. Required for materials and equipment listed in this and other Technical Sections.
      c. Front, side, rear, internal, external elevations, and top and bottom views, showing all dimensions and all to scale.
         1) Locations of conduit entrances and access plates.
         2) Component layout and identification.

3) Complete and detailed bills of materials:
    a) Including quantity, description, manufacturer, and part number for each assembly or component for each control panel.
    b) Include all items within an enclosure.
4) Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium-voltage power cables.
5) Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and Control System equipment.
6) PLC rack and card layout:
    a) Provide a count of current I/O allocation.
    b) Future I/O allocation.
    c) Quantity of spares provided.
7) NEMA rating.
8) Material and finish.

2. Schematics and Wiring Diagrams:
    a. General Requirements:
        1) Submit panel wiring diagrams for every panel that contains wiring.
        2) Use equipment and instrument tags as depicted on the P&IDs for all Submittals.
        3) Nameplates and Wire Labeling:
            a) As specified in Section 26_05_53 - Identification for Electrical Systems or as indicated on the Drawings.
        4) Clearly show modifications to existing circuits:
            a) Show existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
    b. Include the following information:
        1) Name of panel.
        2) Wiring sizes and types.
        3) Terminal strip numbers.
        4) Terminal identification for device and field connections.
        5) Wire tags and labels.
        6) Functional name and manufacturer’s designation for items to which wiring are connected.
        7) Set points for relays and control or alarm contact settings.
    c. Incorporate equipment manufacturer’s Shop Drawing information into the schematic diagrams in order to document the entire control system.
3. Loop drawings:
    a. General Requirements:
        1) Submit loop drawings for every analog, discrete, fieldbus signal, vendor supplied equipment packages, and control panels.
            a) Includes monitoring, alarming, interlocks, and control devices.
        2) Use equipment and instrument tags as depicted on the P&IDs for all Submittals.
        3) Show and identify each component of each loop or system using requirements and symbols from ISA-5.4.
        4) Provide Drawings for every instrumentation loop system:
            a) Furnish a separate Drawing sheet for each system or loop diagram.

5) Nameplates and Wire Labeling:
    a) As specified in Section 26_05_53 - Identification for Electrical Systems or as indicated on the Drawings.
6) Clearly show modifications to existing circuits:
    a) Show existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
7) Provide loop drawings in the format indicated in the Contract Drawings.

b. Provide a complete index in the front of each bound volume:
    1) Index the loop drawings by systems or process areas.
c. In addition to the ISA-5.4 requirements, show the following details:
    1) Functional name of each loop.
    2) Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
    3) Show all terminal numbers, regardless of the entity providing the equipment.
    4) MCC panel, circuit, and breaker numbers for power feeds to the loops and instrumentation.
    5) Terminal assignments associated with every manhole, pull-box, junction box, conduit, and panel through which the loop circuits pass.
    6) Show vendor control panel, instrument panel, conduit, junction box, equipment and PCS terminations, termination identification, wire numbers and colors, power circuits, and ground identifications.
    7) Cables required for communication requirements.

4. PLC I/O List:
    a. A complete listing of the PCS system point I/O database:
        1) Include for each data point relevant parameters such as range, contact orientation, limits, incremental limits, I/O hardware address, and PLC assignment.
        2) Organize on a site-by-site basis and separate by point type.
        3) In addition to the active I/O points, list the implemented spare I/O points and the available I/O points remaining on each card, as well as other defined future points specified or shown.
        4) Upon completion of the Work, update I/O lists to indicate the final as-built configuration of the systems:
            a) Organize as-built I/O list on a site-by-site basis, separated by equipment and point type.
5. Control Descriptions:
    a. For each control loop, provide programming logic in the form of a written functional description of the operation of the equipment, signals, and controls based on the requirements as specified in Section 40_61_15 - Control Strategies, Section 40_61_16 - Specific Control Strategies, and as shown on the P&IDs:
        1) Functional descriptions shall be modified to reflect the actual programming to be implemented in the PLCs.
        2) Include each function depicted or described in the Contract Documents.
        3) Include within the Control Description content:
            a) Specific requirements.
            b) Common requirements that pertain in general to all loops.

c) Listing ranges, setpoints, timers, values, counter values, etc.
d) Manual keyboard entries.
e) Entry codes.
f) System responses.
g) Modes:
(1) Startup.
(2) Routine and normal operation.
(3) Regulation and control.
(4) Shutdown under specified modes of operation.
(5) Emergency operating shutdown.

6. Instrument Datasheets:
   a. The datasheets provided with the instrument specifications are preliminary and are not complete but are provided to assist with the completion of final instrument datasheets. Additional datasheets may be required.
   b. Furnish fully completed datasheets for each instrument and component according to ISA-20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   c. Format: Provide datasheets in Microsoft Word or Microsoft Excel.
      1) Features and options that are furnished.
   d. Provide completed datasheet as specified in the Technical Sections and for each control system component.
7. Instrument Installation Drawings:
   a. Provide instrument installation, mounting, and anchoring details for components and assemblies, including access requirements and conduit connection or entry details.
   b. Each installation shall be identified by the equipment or instrument by tag number.
   c. Provide certification by the instrument manufacturer that the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable.
   d. Provide, at a minimum, the following contents for each detail:
      1) Necessary sections and elevation views required to define instrument location by referencing tank, building, or equipment names and numbers, and geographical qualities such as north, south, east, west, basement, first floor, etc.
      2) Ambient temperature and humidity where the instrument is to be installed.
      3) Corrosive qualities of the environment where the instrument is to be installed.
      4) Hazardous rating of the environment where the instrument is to be installed.
      5) Process line pipe or tank size, service, and material.
      6) Process tap elevation and location.
      7) Upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves.
      8) Routing of tubing and identification of supports.
      9) Mounting brackets, stands, anchoring devices, and sunshades.
      10) Conduit entry size, number, location, and delineation between power and signal.
      11) NEMA ratings of enclosures and components.

12) Clearances required for instrument servicing.
13) List itemizing manufacturer makes, model numbers, quantities, lengths required, and materials of each item required to support the implementation of the detail.

8. Product data:
   a. Provide a technical brochure or bulletin (“cutsheet”) for each instrument or equipment on the project labeled with equipment and instrument tags as depicted on the P&IDs.
      1) Submit with the corresponding datasheets.
      2) Organization: Index product data in the Submittal by systems or loops.
   b. Engineering data:
      1) Test data and performance curves, when applicable.
   c. Manufacturer’s technical reference manuals.
9. Commissioning Submittals:
   a. As specified in Section 01_75_17 - Commissioning.
   b. Manufacturer representative qualifications.
   c. Manufacturer certificates.
   d. Test plans.
   e. Test reports.
   f. Owner Training Submittals.
   g. Operation and maintenance manuals.
      1) Organize the operation and maintenance manuals for each process in the following manner:
         a) Section A - Process and Instrumentation Diagrams.
         b) Section B - Control Panel Drawings.
         c) Section D - Schematics and Wiring Diagrams.
         d) Section E - Loop Drawings.
         e) Section F - Network Diagrams.
         f) Section G - PLC I/O List.
         g) Section H - Control Descriptions.
         h) Section I - Instrument Datasheets.
         i) Section J - Instrument Installation Drawings.
         j) Section K - Product Data.
         k) Section L - Sizing Calculations.
         l) Section M - Test Results.
         m) Section N - Operational Manual.
         n) Section O - Spare Parts List.

1.06 QUALITY ASSURANCE

A. Manufacture instruments at facilities certified to the quality standards of ISO 9001.

B. Provide equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

C. The ICSC must have their own operating UL listed panel fabrication facility.
   1. Panels must be fabricated at this facility and meet UL 508/508A requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt of instruments in the field:
   1. Outside of the package: Prominently display tag number identification.
   2. On each instrument: Provide a nameplate as specified in this Section.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

B. Area classifications:
   1. Furnish enclosures that match the area classifications as specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Project PCIS overview conference:
   1. Contractor leads the meeting.
   2. Timing:
      a. Prior to start of ICSC Work.
   3. Attendees:
      a. Engineer, Owner, ICSC and ICSC's programmer.
      b. Contractor.
      c. Electrical subcontractor.
      d. Manufacturers furnishing major pieces of equipment must attend, including, but not limited to:
         1) Vendor control panels.
         2) Chemical feed systems.
         3) Motor control centers.
         4) Switchgear.
         5) Variable frequency drives.
         6) Lighting.
         7) Engine generators.
   4. Agenda:
      a. Meeting purpose:
         1) Review the entire project, equipment, control philosophy, schedules, and Submittal requirements.
      b. Review entire project.
      c. Review equipment lists.
      d. Review control philosophy.
      e. Review schedules.
      f. Review Submittal requirements.
      g. Safety and security.
      h. Action items.
      i. Next meeting.

B. System configuration meetings: Meet on at least the following occasions:
   1. Preliminary meeting:
      a. Contractor leads the meeting.
      b. Timing:
         1) Before configuration work is begun.

c. Attendees:
    1) Engineer, Owner, ICSC, and ICSC's Programmer.
d. Agenda:
    1) Meeting purpose:
        a) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.
    2) Review the ICSC provided examples of displays, display symbols, reports, etc., to show the capabilities of the system software.
    3) Safety and security.
    4) Action items.
    5) Next meeting.

2. Development review meeting:
    a. Contractor leads the meeting.
    b. Timing:
        1) After the initial database is entered and typical screens and reports have been entered.
    c. Attendees:
        1) Engineer, Owner, ICSC, and ICSC's Programmer.
    d. Agenda:
        1) Meeting purpose:
            a) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.
        2) Review the system configuration.
        3) Review the HMI system database.
        4) Review the control schemes.
        5) Review the displays.
        6) Review the report formats.
        7) Safety and security.
        8) Action items.
        9) Next meeting.
3. Pre-submittal review meeting:
    a. Contractor leads the meeting.
    b. Timing:
        1) Before producing any Submittals.
    c. Attendees:
        1) Engineer, Owner, ICSC, and ICSC's Programmer.
    d. Agenda:
        1) Meeting purpose:
            a) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.
            b) Review an informal hardcopy of developed HMI screens for review by the Engineer.
        2) Review the system configuration.
        3) Review the HMI system database.
        4) Review the control schemes.
        5) Review the displays.
        6) Review the report formats.
        7) Review an informal hardcopy of developed HMI screens.
        8) Review the Submittal schedule.
        9) Safety and security.

10) Action items.
11) Next meeting.

4. Final review meeting:
   a. Contractor leads the meeting.
   b. Timing:
      1) After initial completion of configuration work.
      2) Prior to the Source Test.
   c. Attendees:
      1) Engineer, Owner, ICSC's Programmer, and ICSC.
   d. Agenda:
      1) Meeting purpose:
         a) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.
      2) Review the system configuration.
      3) Review the HMI system database.
      4) Review the control schemes.
      5) Review the displays.
      6) Review the report formats.
      7) Safety and security.
      8) Action items.
      9) Next meeting.
   e. Make final format revisions after this review.
5. Additional requirements as specified in the following:
   a. Section 40_61_15 - Control Strategies.
   b. Section 40_61_16 - Specific Control Strategies.
   c. Section 40_64_01 - Control Systems: Programmable Logic Controllers.
   d. Section 40_68_16 - Control Systems: PCS Software.

C. Control logic meetings: Meet on at least the following occasions:
1. Preliminary meeting:
   a. Contractor leads the meeting.
   b. Timing:
      1) Before configuration work is begun on any PLCs programmed by the Contractor (including those provided through Subcontractors and Suppliers).
   c. Attendees:
      1) Owner, Engineer, ICSC's Programmer, and ICSC.
      2) Individuals responsible for programming PLCs and other programmable devices supplied by the Contractor may attend by telephone conference call.
   d. Agenda:
      1) Meeting purpose:
         a) Discuss overall control logic.
      2) Review list of each PLC and other programmable devices that will interface to the rest of the control system, including make, model, and a description of the interface.
      3) Review contact information for each individual responsible for programming each said PLC and other programmable device.
      4) Review schedule of Submittals that will contain HMI/LOI interface information.
      5) Safety and security.

6) Action items.
7) Next meeting.

2. Development review meeting:
   a. Contractor leads the meeting.
   b. Timing:
      1) After approximately one-half of the HMI/LOI interface Submittals have been submitted.
   c. Attendees:
      1) Owner, Engineer, ICSC's Programmer, and ICSC.
      2) Individuals responsible for programming PLCs and other programmable devices supplied by the Contractor may attend by telephone conference call.
   d. Agenda:
      1) Meeting purpose:
         a) Discuss progress on control logic.
      2) Discuss HMI/LOI interface Submittals to date.
      3) Discuss HMI/LOI interface future Submittals and their requirements.
      4) Discuss half of the screens "drafted" but not submitted.
      5) Review list of each PLC and other programmable devices that will interface to the rest of the control system, including make, model, and a description of the interface.
      6) Review contact information for each individual responsible for programming each said PLC and other programmable device.
      7) Review schedule of Submittals that will contain HMI/LOI interface information.
      8) Safety and security.
      9) Action items:
         a) Document Vendor Control Panel programming requirements.
      10) Next meeting.
3. Pre-submittal review meeting:
   a. Contractor leads the meeting.
   b. Timing:
      1) Before producing any Submittals.
   c. Attendees:
      1) Engineer, Owner, ICSC's Programmer, and ICSC.
   d. Agenda:
      1) Meeting purpose:
         a) Coordinate Submittals.
      2) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.
      3) Review an informal hardcopy of developed HMI screens for review by the Engineer to determine that requirements are being sufficiently met.
      4) Review the Submittal schedule.
      5) Safety and security.
      6) Action items.
      7) Next meeting.
4. Vendor control panel programming meetings:
   a. Contractor leads the meeting.
   b. Timing:
      1) Prior to start of vendor control panel programming Work.

c. Attendees:
    1) Owner, Engineer, ICSC's Programmer, and ICSC.
    2) Individuals responsible for programming PLCs and other programmable devices supplied by the Contractor may attend by telephone conference call.
    3) Each equipment supplier who is providing equipment with a PLC and/or LOI.
d. Agenda:
    1) Meeting purpose:
        a) Coordinate control logic requirements for specific equipment.
    2) Review minimum Vendor Control Panel programming requirements:
        a) PLC to PLC global data mapping.
        b) PLCs to HMI tags mapping.
        c) Communication methods.
    3) Review advanced Vendor Control Panel programming requirements, as applicable:
        a) Tag naming conventions.
        b) LOI screen colors and navigation.
        c) Interlock and permissive definitions.
        d) Alarms: Clearing, formats, colors, and status.
        e) Standard code blocks for common control functionality.
    4) Safety and security.
    5) Action items.
    6) Next meeting.

5. Final review meeting:
    a. Contractor leads the meeting.
    b. Timing:
        1) After HMI/LOI interface Submittals have been submitted.
    c. Attendees:
        1) Owner, Engineer, ICSC's Programmer, and ICSC.
        2) Individuals responsible for programming PLCs and other programmable devices supplied by the Contractor may attend by telephone conference call.
    d. Agenda:
        1) Meeting purpose:
            a) Discuss HMI/LOI interface Submittals and requirements.
        2) Review minimum programming requirements:
            a) PLC to PLC global data mapping.
            b) PLCs to HMI tags mapping.
            c) Communication methods.
        3) Review advanced requirements, as applicable:
            a) Tag naming conventions.
            b) LOI screen colors and navigation.
            c) Interlock and permissive definitions.
            d) Alarms: Clearing, formats, colors, and status.
            e) Standard code blocks for common control functionality.
        4) Safety and security.
        5) Action items.
        6) Next meeting.

6. Additional requirements as specified in the following:
    a. Section 40_61_15 - Control Strategies.
    b. Section 40_61_16 - Specific Control Strategies.
    c. Section 40_64_01 - Control Systems: Programmable Logic Controllers.
    d. Section 40_68_16 - Control Systems: PCS Software.

PART 2 PRODUCTS

2.01 GENERAL

A. Furnish meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of Submittal of the Shop Drawings unless otherwise specified to match existing equipment.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Non-conditioned spaces:
    1. Provide additional temperature conditioning equipment to maintain equipment in non-conditioned spaces subject to these ambient temperatures, with a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature, as determined by the equipment manufacturer’s guidelines.

B. Outdoor installations:
    1. Provide electrical, instrumentation and control equipment suitable for operation in the ambient conditions where the equipment is located.
    2. Provide heating, cooling, and dehumidifying devices incorporated into and included with electrical equipment, instrumentation and control panels to maintain the enclosures within the rated environmental operating ranges as specified in the Sections for the equipment.

C. This facility includes classified areas:
    1. As specified in Section 26_05_00 - Common Work Results for Electrical.
    2. Provide enclosures suitable for the area classification.
    3. Where suitable enclosures are not available, utilize other methods such as intrinsic safety barriers.

D. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of within 0.5 percent of full scale and a minimum repeatability of within 0.25 percent of full scale.

E. Furnish current version of software unless specifically noted in the Contract Documents.
    1. Use of an older version to maintain functionality of an existing system is acceptable with written permission from the Engineer.
    2. Equipment or software with limited support or end of life with the vendor is not acceptable.

F. Discrete circuit configuration:
   1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
   2. Alarm contacts: Fail to the alarm condition.
   3. Control contacts fail to the inoperative condition unless otherwise indicated on the Drawings.

G. Grounding:
   1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
   2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable.
   3. Insulate the shielding and exposed drain wire for each signal cable with heat-shrink tubing.
   4. Terminate the signal cable shield on a dedicated grounding terminal block.
   5. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.

H. Instrument air:
   1. Where indicated on the Drawings, provide dry, filtered control air at 30 pounds per square inch gauge nominal pressure piped to field instruments and instrument panels requiring air:
      a. Provide each field instrument with an integral, non-adjustable filter/regulator assembly to provide regulated air.
      b. Provide each instrument panel requiring air with an adjustable filter/regulator assembly with gauge and an air manifold to provide air to pneumatic instruments.
      c. Filter air to 5-micron maximum particle size.
      d. Provide low pressure switch to alarm on insufficient air supply.

I. Terminal blocks:
   1. Schematics do not reflect the actual conductor routing. Add intermediate terminal in enclosures and equipment as needed based on the actual conductor routing.

J. Signal transmission:
   1. Analog signals:
      a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable, unless otherwise indicated.
      b. Furnish electrical analog signals outside control panels that are 4 to 20 mA 24 VDC, except as indicated.
      c. Electrically or optically isolate analog signals from other signals.
      d. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit’s rating.
      e. Maintain the total 4 to 20 mA loop impedance to 10 percent below the published value at the loop operating voltage.
      f. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.
   2. Pneumatic signals:
      a. Pneumatic signals: 3 to 15 pounds per square inch gauge.

3. Discrete input signals:
    a. As indicated in the controller hardware specification.
4. Discrete output signals:
    a. Dry contacts or TRIAC outputs (with express written approval by the Engineer) as needed to coordinate with the field device.
    b. Provide external terminal block mounted fuse with blown fuse indication for discrete outputs.
    c. Provide interposing relays for discrete outputs for voltage and/or current compatibilities.
    d. Provide interposing relays as required for functionality of the control circuit.
5. Signal performance and design criteria:
    a. Stability:
        1) After controls have taken corrective action, oscillation of the final control element shall not exceed 2 cycles per minute or a magnitude of motion of 0.5 percent of full travel.
    b. Response:
        1) Any change in setpoint or controlled variable shall produce a corrective change in position of the final control element and stabilized within 30 seconds.
    c. Agreement:
        1) Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.
    d. Repeatability:
        1) For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position the final element.
    e. Sensitivity:
        1) Controls shall respond to a setpoint deviations and measured variable deviations within 1.0 percent of full scale.
    f. Performance:
        1) Instruments and control devices shall perform in accordance with the manufacturers' specifications.

2.03 ACCESSORIES

A. Provide flow conditioning devices or other required accessories as needed to meet the accuracy requirements in the Contract Documents.

PART 3 EXECUTION

3.01 INSTALLATION

A. PCIS configurations are diagrammatic:
    1. Locations of equipment are approximate unless dimensioned.
    2. Where Project conditions require, make reasonable changes in locations and arrangements.

B. Field instruments installation:
   1. Install field instruments as specified in the Contract Documents, API RP 550 and RP 551, and the manufacturer's instructions.
   2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
      a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the Drawings.
      b. Provide sun shields for field electronic instruments, panels, and enclosures located outdoors. Sun shields shall include standoffs to allow air gap between shield and equipment.
      c. Orient LED, LCD, or other readout screens north to minimize sun glare and reduce potential of sun damage.
   3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
      a. Type of flexible conduit required for the area classification:
         1) Area classification as specified in Section 26_05_00 - Common Work Results for Electrical.
      b. Maximum length of 18 inches.
   4. Connect field instruments with cable as specified in the Electrical Specifications, except when the manufacturer requires the use of special cable, or otherwise specified in this Section:
      a. Special cable applications shall be in accordance with the NEC.
   5. Verify the correctness of each installation:
      a. Polarity of electric power and signal connections.
   6. Ensure process connections are free of leaks.

C. Process sensing lines and air tubing:
   1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
   2. Provide supports for rigid tubing at intervals of not more than 3 feet.
   3. Slope horizontal runs of instrument tubing at a minimum of 1/16-inch per foot to allow for draining of any condensate.
   4. Bends:
      a. Make bends for parallel lines symmetrical.
      b. Make bends without deforming or thinning the walls of the tubing.
   5. Square-cut and clean ends of tubing before being inserted in the fittings.
   6. Provide bulkhead fittings at panels requiring pipe and/or tubing entries.
   7. Use stainless steel tubing for piping hard piped from the air header, unless otherwise indicated on the Drawings or not compatible with the fluids or atmosphere in the area:
      a. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times maximum travel of the equipment.

D. Cable and conductor termination:
   1. Terminate cables and conductors on terminal blocks.
   2. Terminal block enclosures:
      a. Suitable for the area classification as specified in Section 26_05_00 - Common Work Results for Electrical.

E. Surge protection:
   1. Provide outdoor field instrument loops with voltage surge protection units installed on the instruments and the panel.
   2. Individually fuse each 4 to 20 mA DC loop with a 1/2-amp fuse between power supplies and receiver surge protectors.
   3. Provide voltage surge protection for 4 wire transmitters and analyzers:
      a. Protect both power source and signal loop.

3.02 RE-INSTALLATION

A. Existing instrumentation:
   1. Clean, recondition and re-calibrate each existing instrument to be reused, removed, or reinstalled using an authorized service facility of the instrument manufacturer.
   2. Provide certification of this Work before reinstallation of each instrument.

3.03 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning and Technical Sections.

B. Functional Testing:
   1. Assist with troubleshooting and correcting instrumentation and control issues.

3.04 ADJUSTING

A. Control valves:
   1. Stroke control valves, cylinders, drives and connecting linkages from the control system as well as local control devices and adjust to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position.
   2. Check control valve actions and positioner settings with the valves in place to ensure that no changes have occurred since the bench calibration.

B. Make revisions necessary to the control system software, as directed by the Engineer.
   1. It is understood that the Contractor knows and agrees that changes will be required in the control system software during commissioning.

3.05 CLEANING

A. Oxygen service devices including piping, valves, and appurtenances shall be cleaned for oxygen service and certified by a qualified inspector prior to placing into service.

B. Vacuum clean control panels and enclosures before process start-up and again after final completion of the project.

C. Clean panel surfaces.

D. Return to new condition any scratches and/or defects.

E. Wipe instrument faces and enclosures clean.

F. Leave wiring in panels, manholes, boxes, and other locations in a neat, clean, and organized manner:
   1. Neatly coil and label spare wiring lengths.
   2. Shorten, re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.

END OF SECTION

SECTION 40_61_15

CONTROL STRATEGIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Contractor-developed loop description submittal requirements.
   2. General programming requirements.
   3. Common control functions:
      a. General control and monitoring functions to be provided throughout the PCS system.
         1) These requirements apply to all systems and supplement the specific loop descriptions in Section 40_61_16 - Specific Control Strategies and information indicated on the Drawings.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Clamp: Imposed upper and lower limits on setpoints to eliminate entries outside the allowable control parameters.
   2. Hardwired control: Control circuitry that does not utilize software to initiate functionality.
   3. Hardwired interlocks: A safety or protective feature that will interrupt equipment operation in all operating modes with no required operator intervention.
   4. Historize: To store data collected by a Supervisory Control and Data Acquisition system or Distributed Control system in a Historical Server or Historian for later use in trends and reports.
   5. Network link status: A proving register that allows the PCS to know if a PLC has lost communications with the PCS.
   6. Network time synch: Coordination of all PLCs in the system to one consistent time based on a server, GPS clock, or some other mechanism to set a global time.
   7. Software interlocks: A safety or protective feature interrupting equipment operation when the PLC has control.
   8. Software permissive: A protective feature that will prevent a piece of equipment from starting. Will not stop the equipment once it’s running.
   9. Slew rate: Rate of change with respect to time.
   10. Watchdog timer: Timers imposed to test components such as discrete I/O to verify the health of the card.

1.04 SUBMITTALS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.05 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PROGRAMMING REQUIREMENTS

A. General:
   1. Use re-usable data types for variable names or aliases derived from tag and loop identification on the P&IDs for the equipment/instruments. For example:
      a. PMP_101.Auto.
      b. PMP_101.Running.
      c. PMP_101.Fault.
      d. PMP_102.Auto.
      e. PMP_102.Running.
      f. PMP_102.Fault.
   2. Use variable names or aliases derived from tag and loop identification on the P&IDs for all process values.
      a. Submit names for Owner approval.
      b. Unless otherwise noted, utilize a floating-point format for PLC algorithms and calculations.
      c. Provide PLC logic to convert raw input values into engineering units in a floating-point format.
   3. Store all adjustable parameters in the PLC and configure them so that an operator with sufficient security access can change the parameters from the HMI. Update and display the current value at all locations, regardless of where the last change was made.
   4. Reusable PLC code blocks:
      a. Develop and use new standard user defined function blocks (UDFBs) and user defined types (UDTs) where appropriate. One instance of each standard code block shall reside in each PLC and shall be referenced in main routines and subroutines.
      b. New code blocks that the Contractor would like to use as a standard shall be submitted to the Owner for review and approval.
      c. Provide a complete library of standard code blocks to Owner as part of O&M documentation.
   5. Documentation:
      a. All control logic shall be annotated, including rungs, instructions, and tags.
      b. Each routine shall have a title and a detailed description in complete sentences of the control strategy represented by the control logic. Where parameters are passed to the routine, all parameters shall be defined in

the routine description. Analog tag descriptions representing process variables shall include the engineering unit range of the analog variable.

c. Digital tag descriptions shall include the On and Off state labels.
d. Analog tag descriptions representing process variables shall include the engineering units' range of the analog variable.
e. Equations developed in the process logic shall be fully documented in the rung or routine description. This description should include a description of each constant and variable utilized in the equation, including engineering units.

6. Program slew rates for setpoints as needed to limit the effect of updated setpoints on the process:
   a. Provide for control setpoints and manual speed and position selections.
   b. Store new setpoints in 1 register and gradually ramp the actual setpoint register at the slew rate until it reaches the new value.
   c. Provide operator access to change slew rates from the HMI.
7. Setpoints:
   a. Provide an operator selection to save all setpoint values.
   b. Furnish 1 or more screens at the HMI that display the initial values for all setpoints defined during start-up and the value for each setpoint the last time they were saved.
   c. Where possible, use a DFB or AOI to provide an operator selection to restore all setpoints to the initial start-up value.
   d. Provide an operator selection to restore all setpoints to the last saved value.
8. Store a copy of adjustable parameters and accumulated and integrated totals in PCS:
   a. Upon re-loading of the PLC program, re-load these values to the PLC from PCS or processor memory card.
   b. PLCs provide a minimum 2-week data storage to provide for data accumulation and later communication to the Historian in the event of a network interruption.
9. Calculated values:
   a. Program calculations such that division by zero errors cannot occur.
   b. Prevent calculations from generating values that exceed the limits of the equipment or data type structures (integers) internal to the PLC.
   c. Configure counting functions (start counts and operation counts) to allow a minimum of 10,000 counts and roll over to zero at an even decimal interval (1 followed by 4 or more zeros).
   d. Configure integrating functions to accurately accumulate the maximum rate from the instrument/equipment (totalizers, run time meters) for 30 years. Utilize manufacturer AOI/DFBs etc., where possible.
10. Timers:
    a. Provide programmable settling and proving timers in control sequences as required for starting and stopping of equipment to allow the process to settle to a steady state before proceeding with any additional control functions.
       1) Settling timers may be overridden by setting the timer to 0 seconds.

11. Control Panel status:
    a. Design the PLC system to function as a stand-alone unit that performs all of the control functions described in this Section completely independent from the functions of the PCS system PC-based operator interfaces:
        1) Failure of the PCS system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
    b. Furnish a minimum of 1 screen that depicts the status of enclosures containing PLCs, communication equipment, UPS or I/O in the control system, including, but not limited to, the following:
        1) PLC cabinet over-temperatures from high temperature switch.
        2) Intrusion status on enclosures equipped with intrusion switches.
        3) AC power failure:
            a) Monitor ahead of UPS.
        4) DC power supply failure:
            a) For redundant power supplies, alarm when either power supply or the diode bridge fails.
        5) UPS failure signal.
        6) UPS low battery signal.
        7) Digital bus network coupler and or gateway failure signal.
        8) Ethernet switch failure signal.
12. Network link status:
    a. Alarm on the loss of communications between any PLCs (vendor or plant).
    b. Use produced/consume tags to monitor PLC to PLC communications.
    c. Coordinate with all vendor PLCs so that they match the plant PLC monitoring methods.
13. PLC system communication status:
    a. Generate a communications alarm if a communication fault is detected or there is no response from a node for more than a user-specified time.
    b. In the event of communications loss:
        1) Continue normal operation at each PLC.
        2) Where control parameters are received over a communications link:
            a) If a link fails where process elements use the remote value for closed-loop control, hold operating status, speed, and position of the process elements at their last state before the communication alarm, unless other I/O local to that PLC indicates shutdown or override conditions.
            b) If a link fails where process elements use the remote value to determine setpoints, continue to operate using the last value received:
                (1) Provide a manual override entry at SCADA to allow an operator to enter a different value for any such remote signal.
                (2) Generate an alarm whenever an override value is in use.

B. Common control functions:
    1. Incorporate common control functions into control loops and devices and into the control programming, whether or not specifically shown in the specific control descriptions or elsewhere in the Contract Documents.
    2. Alarms:
        a. Indicate alarms at SCADA. Enable acknowledgement from SCADA.

b. Generate and include the following alarms for all analog or equivalent network signals.
    1) Low.
    2) Low-low.
    3) High.
    4) High-high.
    5) Out of range.
    6) Rate of change.
    7) Stale.
c. Indicate alarms at SCADA. Enable acknowledgment from SCADA.
d. Generate high, high-high, low, and low-low level alarms where indicated:
    1) Provide an alarm reset deadband for each analog value to prevent excessive repeated alarms.
    2) Provide logic and timers to inhibit analog alarms based on process events. For example, inhibit low-flow alarms when a pump is stopped or has not been running long enough to establish flow.
e. Flash alarm and fail conditions and their respective indicators on the PCS graphic screens and local indicating lights until the condition is acknowledged by the operator, even if the alarm condition is no longer present.
f. Once an operator acknowledges the alarm, display alarm conditions in a steady state (not flashing) while the alarm condition is still present:
    1) Flash with a cycle rate of 1/2 second on and 1/2 second off.
g. Once the alarm has been cleared and the operator has acknowledged the alarm or fail condition, turn the graphic alarm indicator off.
h. For alarms that do not have inherent timers, provide an operator-adjustable proving timer to limit nuisance alarms, continuously adjustable from 0 seconds to 100 minutes. The initial setting of proving timers shall be 0 seconds:
    1) PLC shall start the timer when it first detects an alarm condition and only activate it after the timer has expired.
    2) If the alarm condition clears while the timer is running, the timer shall reset, and the alarm shall not be activated.
i. Use interlocks and proving timers to prevent alarms from operating due to power loss, except for loss of power alarms.
j. Furnish an alarm silence pushbutton at each PCM or LCP with an audible alarm to signal the PLC to turn off the audible alarm until the next alarm occurs.
k. Lamp test: Furnish lamp test pushbuttons at each control panel with more than 10 pilot lights that illuminate all pilot lights on the panel:
    1) May sequence through blocks of lights.
    2) Minimum on time for each lamp during lamp test 15 seconds.
l. Horns and beacons:
    1) Where indicated in the Contract Documents:
        a) Activate PCM horn and beacon on critical alarms and on other alarms as defined by the Facility Alarm Philosophy.
        b) Deactivate PCM horn and beacon when PCM reset pushbutton is activated.
        c) Silence PCM horn when PCM silence pushbutton is activated.

m. Dual analog instruments:
    1) For applications where 2 or more analog instruments are measuring the same process variable:
        a) Generate an operator adjustable percent deviation alarm.
        b) Allow operator to take each instrument out of service when an instrument is out of service.

3. Where a reset is shown for counts, totals and times maintained in the PLC:
    a. Provide a reset selection on the HMI screen that displays the value.
    b. Provide a preset function on the HMI to allow an operator-entered value to become the accumulated total.
    c. Limit access to the reset and preset functions to operators with suitable security levels.
    d. Log the value before reset, including the operator, time, and reset date in the PCS archive.
    e. Log the value before preset, preset value, operator, time, and date of preset in the PCS archive.
4. Count starts for each piece of equipment (off to on transitions of running status) in the PLC:
    a. Display total starts on PCS screens and provide a reset function.
    b. Calculate the number of starts for each day:
        1) Display current day and previous day starts on PCS displays.
        2) Do not reset daily start count when overall count is reset.
        3) Archive starts for each day through PCS.
    c. Calculate the number of starts per hour. Alarm when the number of starts per hour exceeds the manufacturer limit.
5. Run time accumulation:
    a. Integrate accumulated run time to the nearest 0.1 hour whenever the running status input indicates that the equipment is running:
    b. Display total run time in hours on PCS screens.
    c. Where indicated, calculate the total run time for each day:
        1) Display the current day and the previous day's run time on the HMI to the nearest 0.1 hour.
        2) Do not reset daily run time when overall time is reset.
        3) Archive run time for each day through PCS.
6. For all monitored analog values:
    a. Convert values to engineering units in floating-point format within the PLC.
    b. Maintain trends in PCS.
        1) Display minima and maxima on the HMI, and archive through PCS.
    c. Flows and weights:
        1) Totalize flows in the PLC logic:
            a) Where totalized flows are input to a discrete input, count input pulses and multiply by the volume per pulse.
            b) Where no totalizer input is shown, integrate the analog input over time.
            c) Display totals at SCADA.
            d) Archive totals to the historical database through PCS.
    d. Generate an alarm whenever an override value is in use.
    e. Calculate hourly, daily, and monthly averages:
        1) Display averages on the HMI, and archive through PCS.

f. Calculate minimum and maximum values each day, and month:
    1) PLC or PCS may perform calculations.
    2) Display minima and maxima on the HMI, and archive through PCS.

7. Analog data processing:
    a. Engineering unit conversion:
        1) Use engineering units for all analog point values. Convert analog inputs to engineering units.
    b. Analog magnitude checking:
        1) Provide upper and lower limits to prevent operator-entered values (setpoints, etc.) from falling outside acceptable limits.
    c. Analog value quality:
        1) Monitor analog values received at each PLC from analog inputs or communications from another PLC or RIO specific to critical analog values, and generate alarms for the following conditions:
            a) Rate of change in excess of acceptable limit:
                (1) Provide a separate rate limit for each value.
            b) Stale value:
                (1) For analog signals that come from analog inputs or calculations using analog inputs, which are expected to have some variation each time the input is read, alarm when there is no change in the value for 10 times the normal expected scan or communication update.

8. I/O filtering and processing:
    a. Analog input filtering:
        1) For each analog input, provide an adjustable first-order filter for the purpose of smoothing out spikes and other noise for analog transmitter input signals. By default, configure analog inputs with no filtering effect.
        2) Monitor analog input signal quality:
            a) Over range: Input value is above the normal range (typically over 21 mA).
            b) Under range: Input value is below the normal range (typically under 3 mA, indicating a probable broken connection).
            c) Generate alarms for over- or under-range inputs.
            d) Do not use over- or under-range values for control or calculation purposes:
                (1) Where a second instrument is provided to monitor the same condition (a redundant instrument or additional instruments furnished for averaging or different operating modes) and has a valid signal, use that input for control.
                (2) Otherwise, hold all outputs affected by the signal at their last values before the signal went out of range.
        3) Digital input filtering (proving timer):
            a) Provide an adjustable time delay function (0 to 10 seconds) on discrete input for de-bouncing.
            b) By default, discrete inputs shall be configured with de-bounce timers set to zero seconds.

9. Levels:
    a. Level measurements:
        1) All level readouts displayed by the PLC or SCADA shall be displayed in the actual level of the fluid or plant elevation, whichever the Owner desires.
    b. Tank and vessel levels:
        1) Display as a level (typically in feet of liquid), volume (typically in gallons) and percentage of rated capacity (percent):
            a) Some individual displays may only be level or volume when agreed to by the Owner and Engineer during screen review meetings.
        2) Monitor the rate of change of volume on tanks and vessels:
            a) Establish the maximum withdraw rate at which the volume should decrease (all pumps or feeders operating at maximum output). Generate an alarm whenever the volume decreases faster than this rate.
            b) Establish the maximum fill rate at which the volume should increase when filling.
                (1) Generate an alarm whenever the volume increases faster than this rate.
                (2) Verify tank and vessel levels are fluctuating to verify the validity of the IO register.
10. If it is determined the register is not active or failed in a manner that leaves a stagnant value generate an alarm.
11. PCS MANUAL-AUTO:
    a. Where indicated, provide MANUAL-AUTO and START-STOP selections in the PCS, accessed from an HMI for operators with sufficient security, to provide the following operating modes:
        1) PCS AUTO: Normal, automatic control mode of the strategy allows complete PLC control in response to process conditions and programmed sequences.
        2) PCS MANUAL: Enables PCS manual control where control decisions are made by an operator through the PCS START-STOP, OPEN/CLOSE, or other selections as indicated.
        3) Program the PLC so that switching a strategy between AUTO and MANUAL (either direction) occurs with a smooth transition.
            a) Keep running or position status unchanged when control is switched to MANUAL until a change is requested using the operator selections (START, STOP, OPEN, CLOSE).
            b) Keep running and position status unchanged when control is switched to AUTO until the control logic determines a change is required.
12. Display the status of all operator selections (PCS MANUAL/AUTO, PCS START/STOP, etc.) on the PCS.
13. Interlocks:
    a. Implement software interlocks as indicated to place equipment in a safe condition in response to impending hazardous process conditions. Apply software interlocks when equipment is operating in PCS AUTO or PCS MANUAL.

14. Permissives:
    a. Implement software permissives where indicated to prevent equipment from starting in an unsafe condition.
    b. Apply software permissives when equipment is operating in PCS AUTO or PCS MANUAL.
15. Process control algorithms:
    a. Jog and hold:
        1) When the error between process variable and setpoint is beyond a setpoint deadband:
            a) Jog valve or ramp speed in the required direction for a preset “Jog Time” or until the process variable reaches or passes the setpoint.
            b) Then hold speed or position through a setpoint “Hold Time.”
            c) Continue alternating jog and hold until the error is less than the deadband.
        2) Provide operator access to jog time and hold time setpoints from the HMI.
    b. PID algorithms:
        1) Provide a PID faceplate with the following displays and functions for each PID control algorithm:
            a) Display Output, CV.
            b) Display Setpoint, SP.
            c) Display Process Variable, PV.
            d) Allow for operator selection of automatic or manual control of the output.
            e) Under manual control of output, allow the operator to enter the desired output value.
            f) Allow for input of the 3 proportional, integral, and derivative tuning parameters.
            g) Configure PID loops to prevent reset windup when controlled equipment is operating in manual (local or PCS), or when the equipment has reached a physical limit.
            h) When controlled equipment is being operated in remote PCS MANUAL, configure the PID function to track the process variable to provide a smooth transfer between manual and automatic modes.
            i) Provide selectable slew rates with adjustable setpoints to allow the PID algorithm to slowly ramp to its final value to minimize system disturbance.
16. Equipment alternating and sequencing:
    a. Distribute number of starts and run time equally between identical equipment.
    b. Where multiple pieces of equipment are used to control a single process variable, alternating of lead and lag equipment assignments is done as follows:
        1) Automatic lead/lag equipment selection:
            a) Control system automatically selects the lead equipment and next lag equipment based on the lowest run time hours of the equipment.

b) When multiple equipment is running, the control system determines which equipment to stop next based on the running equipment with the highest run time hours.
c) A weighted run time factor can be assigned to each individual piece of equipment.
(1) Weighting factor is a percentage from 1 to 100 percent that is multiplied by the actual run time hours of the equipment to create a weighted run time hours of the equipment.
(2) Weighted run time hours of each piece of equipment are then used by the algorithms that select the equipment that will start or stop next.
(3) This is to allow for specific equipment to accrue more run time hours so that all pumps do not reach their maximum run time hours at approximately the same time.
(a) Display both the weighted and actual runtime hours on the PCS screen.

2) Manual lead/lag selection:
a) Operator will assign the lead, “Next Lag” equipment through a selection matrix in the HMI.
b) When modifying this matrix, modifications shall not become active until an “ACCEPT ALL” software pushbutton is activated.
c) Provide a “CANCEL ALL” software pushbutton to clear all modification of the selection matrix and revert them to the last accepted changes.

17. Motor control:
a. Monitor the device’s LOCAL-OFF-REMOTE (LOR) switch (the hard-wired switch at the MCC, drive or equipment) to determine when the PLC has control of the associated equipment:
1) Display current REMOTE status on the PCS screens.
b. Monitor the device’s running status from the starter auxiliary or run status input:
1) Display the current status (running or stopped) on the PCS screens.
2) Use status to calculate total run time and daily run time, and to count total starts and daily starts.
3) Provide a time stamp for each start.
4) Provide software for motors 200 horsepower and greater to prevent exceeding the manufacturer’s recommended maximum starts per hour.
c. When equipment control has been given to the PLC as reported by the LOCAL-OFF-REMOTE switch, allow selection of PCS AUTO or PCS MANUAL control modes based upon operator selection using the PCS screens.
d. Starting, stopping and running when the device LOR is in LOCAL:
1) With the LOR switch in the LOCAL position, the motor is controlled by the START and STOP pushbuttons.
2) With the LOR switch in the OFF position, the motor is prohibited from running.
3) With the LOR switch in the REMOTE position, the motor is controlled remotely.

e. Starting, stopping, and running when the device LOR is in REMOTE:
    1) When the motor is expected to be running (PLC has issued a START or RUN due to process conditions or operator selection), LOR is in REMOTE, and the device is not reported to be running, start an operator adjustable “Control Activation” timer:
        a) Provide “Control Activation” timers for each piece of controlled equipment:
            (1) If the LOR and required running status do not change, and the PLC does not receive running status within the “Control Activation” time period:
                (a) De-activate the output.
                (b) Place the device in a “Failed” state.
                (c) Generate a “Failed to Respond” alarm.
    2) When the motor is not expected to be running (PLC has issued a STOP or removed the RUN output), LOR is in REMOTE, and the device is reported to be running, start the “Control Activation” timer:
        a) If the LOR and required stopped status do not change, and the PLC does not lose the running status within the “Control Activation” time period:
            (1) Keep the RUN output off or the STOP output on.
            (2) Place the device in a “Failed” state.
            (3) Generate a “Failed to Respond” alarm.
    3) Re-establish PLC control of a device in a “Failed” state only after one of the following:
        a) An operator turns the device’s LOR switch out of REMOTE, and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).
        b) An operator acknowledges the fault from the PCS.
f. Where motor winding high-temperature switches or RTD temperature elements are shown, generate an alarm when a high temperature is sensed (contact opens or temperature above the high alarm setpoint), but do not stop the motor unless otherwise indicated.
g. Motor equipped with current detection shall shut down and report a “failed” status for high current detection.
h. Control 2-speed motors similar to other motors, except as listed below:
    1) Motor states are RUN-FAST, RUN-SLOW, and STOP.
    2) Start 2-speed motors in the RUN-SLOW state. If or when the high speed is required (RUN-FAST operator selection or process conditions), transition to RUN-FAST after a designated time.
    3) When transitioning from RUN-FAST to RUN-SLOW, remove the RUN-FAST output or issue a STOP, then wait for a “Fast to Slow” time delay before energizing the RUN-SLOW or START-SLOW output.
i. Simultaneous starts:
    1) Prevent more than 1 motor-driven load 25 horsepower or larger in the same facility from starting concurrently:
        a) When starting 1 load, inhibit start logic for all other such equipment until the load being started is up to speed (RVSS or VFD), or after a setpoint time delay (full-voltage starters and miscellaneous equipment).

j. Speed control:
    1) Modulate speed on VFD-driven motors using jog and hold, or PID control algorithms to maintain process conditions as described in the specific loop descriptions.
    2) Operate speed control within a pre-defined range:
        a) Minimum speed as determined by equipment manufacturer. The higher of:
            (1) Minimum motor speed to maintain adequate cooling for the type of load driven (constant or variable torque).
            (2) Minimum equipment speed, such as minimum speed to deliver flow or to deliver minimum flow for equipment cooling or lubrication.
        b) Maximum speed 100 percent (60 hertz) or as identified by the equipment manufacturer.
        c) Scale analog signals to control speed at 0 to 100 percent of the operable speed range for the equipment.
    3) Where multiple equipment may operate together to maintain the same process condition, alternatively referred to as “Lead/Lag”:
        a) Start the first equipment at a preset starting speed.
        b) When one or more of the equipment is running and the speed control algorithm reaches a preset “Start Next” speed value (initially 95 percent of speed range) through a preset time delay:
            (1) Start the next available equipment at the preset starting speed.
            (2) Ramp up the started equipment and ramp down the previously running equipment to the mid operating speed (adjustable in the PLC). Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with the new load running at the mid speed (for example if 1 pump is running and the second pump will be added, then the total flow of both pumps running at mid operating speed should be approximately the same as the flow of 1 pump at Start Next speed).
            (3) Once both pieces of the equipment reach the mid-operating speed, resume the speed control algorithm for that equipment.
            (4) Operate equipment at the same speed following the output of the speed control algorithm.
        c) When two or more pieces of equipment are running, monitor for a “Stop Next” condition:
            (1) Where the flow rate is monitored, use a preset “Stop Next” flow rate for each possible number and combination of equipment:
                (a) Determine the initial “Stop Next” speed based on the flow that can be provided with one fewer piece of equipment running at a speed slightly below the “Start Next” speed.

(2) When the “Stop Next” condition exists through a preset time delay:
(a) Ramp speed of running equipment, except for the equipment to be stopped up to a preset value based on the number of items running. Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with 1 fewer load running (typically slightly below the preset “Start Next” speed) while ramping speed of equipment to be stopped down to the preset minimum speed.
(b) Operate remaining equipment at the same speed following the output of the speed control algorithm. Stop the load once it reaches minimum speed.

18. Gate and valve control:
    a. Monitor the device’s LOCAL-STOP-REMOTE (LSR) switch(es) (the integral switch in the actuator or hard-wired switch at the local control station):
        1) Display current REMOTE status on PCS screens.
    b. Start an “Open Activation” timer whenever the device is expected to be open (PLC has issued an OPEN command in PCS AUTO, or OPEN was selected in PCS MANUAL):
        1) Initially set “Open Activation” time to twice the normal opening time.
        2) If the LSR position and open command do not change, and the PLC does not receive fully open status feedback within the “Open Activation” time period:
            a) De-activate the open output.
            b) Place the device in a “Failed” state.
            c) Generate a “Failed to Open” alarm.
    c. Start a “Close Activation” timer whenever the device is expected to be closed (PLC has issued a CLOSE command in PCS AUTO, or CLOSE was selected in PCS MANUAL):
        1) Initially set “Close Activation” time to twice the normal closing time.
        2) If the LSR position and close command do not change, and the PLC does not receive fully closed status feedback within the “Close Activation” time period:
            a) De-activate the close output.
            b) Place the device in a “Failed” state.
            c) Generate a “Failed to Close” alarm.
    d. Limit the number of open/close commands so that it does not exceed the manufacturer requirements.
    e. For modulating valves (valves controlled from either a 4-20 mA signal or digital communications command) with position feedback, start a “Position Error” timer whenever the position feedback differs from the required position command by more than a setpoint error when the LSR is in REMOTE:
        1) For analog modulating devices, the error is determined by position feedback differing from position command by more than the setpoint error.

2) For discrete modulating devices, error is determined by feedback not changing in the correct direction or changing at less than a setpoint rate when the OPEN or CLOSE PLC output is active.
3) Initially, set the “Position Error” time to 60 seconds.
4) If the LSR position does not change, and the position error stays outside of the setpoint error through the “Position Error” time period:
a) Place the device in a “Failed” state.
b) Generate a “Position Fail” alarm.

f. Provide separate time delay settings for each function and for each device.
g. If the valve position inputs indicate an invalid state (i.e., valve open and closed at the same time), place the device in a “Failed” state and generate an “Invalid State” alarm.
h. Re-establish PLC control of a device in a “Failed” state after one of the following:
1) An operator turns the device’s LSR switch out of REMOTE and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).
2) An operator acknowledges the fault from PCS.
i. For all alarm conditions, control other devices (as stopping pumps, etc.) as stated in the individual loop descriptions to make the system safe.
j. For discrete modulating valves (valves positioned to intermediate positions to control process values through discrete OPEN and CLOSE outputs), count the number of actuations (OPEN or CLOSE commands) per hour in the PLC:
1) Display count on the HMI.

19. Chemical systems:
a. Provide the following chemical system screens:
1) One or more screens for each individual chemical system controlled at that location, containing:
a) All status displays (running, failed, etc.).
b) Selections (lead/lag, which process flow to pace to, etc.).
c) Setpoint entry and display.
d) Calculated feed requirement (result of flow pacing calculation) in engineering units (typically milligrams of chemical per minute).
e) Output signal to feeder in percent of full span.
f) Actual chemical flow rate from flowmeter (where shown).
g) Process flow rate(s) used to pace each chemical on the individual chemical screens (PROC FLOW):
(1) Where different process flows can be selected for flow pacing, display and identify the selected source.

b. Chemical system calculations: Perform calculations as indicated on the Drawings and in the individual loop descriptions. Use the following assumptions, unless otherwise noted:
1) Where chemical flow feedback is not used, assume feeder output is linear in response to control signal.
2) Zero signal (typically 4 mA) produces zero flow.
3) Perform flow-pacing calculations using as indicated on the Drawings or described in the individual loop descriptions.
c. Provide the setpoints indicated on the Drawings and in the individual loop descriptions. Typical setpoints include:
1) Q_C: Chemical pump flow rate measured from calibration column at maximum feeder output (typically in gallons of solution per hour).

2) D: Desired chemical concentration in the process stream in engineering units (typically milligrams of chemical per liter of process fluid).
3) Q_f: Process flow measurement upstream of dosage point (typically in million gallons per day of process fluid).
4) ρ: Density of the chemical solution to be fed (typically in pounds per gallon). Used to calculate the concentration of the chemical in the solution.
5) C: Concentration of the chemical in the solution to be fed (typically in decimal format. For example, 0.25 for 25 percent chemical solution).

d. Provide the selections indicated on the Drawings and in the individual loop descriptions. Typical selections include:
1) OPEN/CLOSED LOOP:
a) Selection of method of controlling chemical flow-paced feed rate.
b) OPEN LOOP: Signal to feeder is based on feeder calibration (Q_C) to deliver calculated chemical solution feed rate. Chemical solution flowmeter is not used for control.
c) CLOSED LOOP: Chemical feed rate is directly controlled using the calculated chemical solution feed rate as the setpoint, and the flow rate from the chemical solution flowmeter as the process variable.
2) TRIM FACTOR: Refer to the equations below.

e. Chemical control algorithms:
1) Flow pacing algorithm:
a) Operator selects a desired dose and the control system adjusts the chemical feed rate to dose based on process flow, chemical concentration, and feeder calibration.
b) Calculation is as follows (units may vary from those shown in the calculation below):

Use the following equation to calculate the chemical pump flow rate:

$$Q_C = \frac{D \cdot Q_f \cdot 8.34}{C \cdot p \cdot 24}$$

Where:
Q_C = Chemical Pump Flow Rate (gal/hr)
D = Dose setpoint (mg/L)
Q_f = Process Flow Measurement (MGD)
8.34 = Conversion Factor (lbs • L)/(MG • day • mg)
C = Chemical Concentration (ratio in decimal format. For example, use 0.25 for 25 percent chemical solution)
p = Chemical Density (lbs/gal)
24 = Conversion Factor (days to hours)

Use the following equation to calculate the chemical pump speed control setpoint:

$$S = \frac{Q_C}{Q_{max}}$$

Where:
S = Chemical Pump Speed Control Setpoint (0 to 100 percent)
Q_C = Flow Setpoint From Equation Above (gal/hr)
Q_{max} = Maximum Pump Flow Setpoint Based on Calibration Column Test (gal/hr).

2) Flow pacing with closed loop algorithm:
   a) Operator selects a desired dose and the control system adjusts the speed of the chemical feeder through a speed control signal to match the measured chemical feed rate to a flow rate setpoint.
   b) This flow rate setpoint shall be derived from the process flow and operator setpoints for dosage and concentration.
   c) Calculation is as follows (units may vary from those shown in the calculation below):

   Use the following equation to calculate the chemical pump flow rate:

   $$Q_C = \frac{D \cdot Q_f \cdot 8.34}{C \cdot p \cdot 24}$$

   Where:
   Q_C = Chemical Pump Flow Rate (gal/hr)
   D = Dose setpoint (mg/L)
   Q_f = Process Flow Measurement (MGD)
   8.34 = Conversion Factor [(lbs • L)/(MG • day • mg)]
   C = Chemical Concentration *(ratio in decimal format. For example, use 0.25 for 25 percent chemical solution)*
   p = Chemical Density (lbs/gal)
   24 = Conversion Factor (days to hours)

3) The speed (control variable) of the chemical feed pump shall be determined by the output of a PID controller.
   a) Setpoint of the PID controller shall be the result of the equation in the paragraph above.
   b) Process variable (feedback) shall be the chemical feed flow as measured by a flow meter on the discharge of the chemical feed pump.
4) Flow pacing with analyzer trim algorithm:
   a) Operator selects a desired dose and desired analyzer setpoint band and the control system adjusts the chemical feed rate to dose based on process flow, chemical concentration, process analyzer output, and feeder calibration.
   b) Calculation is as follows (units may vary from those shown in the calculation below):

   Use the following equation to calculate the chemical pump flow rate pre-trim:

   $$Q_{CPT} = \frac{D \cdot Q_f \cdot 8.34}{C \cdot p \cdot 24}$$

   Where,
   Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
   D = Dose setpoint (mg/L)
   Q_f = Process Flow Measurement (MGD)
   8.34 = Conversion Factor [(lbs • L)/(MG • day • mg)]
   C = Chemical Concentration (ratio in decimal format. For example, use 0.25 for 25 percent chemical solution)
   p = Chemical Density (lbs/gal)
   24 = Conversion Factor (days to hours)

Use the following equation to calculate the trim factor:

$$TF = Q_{CPT} \cdot 0.1 \cdot \left(\frac{AI - \frac{1}{2}(QAH + QAL)}{-\frac{1}{2}(QAH - QAL)} \right)$$

Where:
TF = Trim Factor (gal/hr)
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
AI = Analyzer Output to be Used For Trim Calculation
QAH = Analyzer Band High Value
QAL = Analyzer Band Low Value

Use the following equation to calculate the chemical pump flow rate with trim:

$$Q_{CWT} = Q_{CPT} + TF$$

Where:
Q_{CWT} = Chemical Pump Flow Rate with Trim (gal/hr)
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
TF = Trim Factor (gal/hr)

Use the following equation to calculate the chemical pump speed control setpoint:

$$S = \frac{Q_{CWT}}{Q_{max}}$$

Where:
S = Chemical Pump Speed Control Setpoint (0 to 100 percent)
Q_{CWT} = Flow Setpoint from Equation Above (gal/hr)
Q_{max} = Maximum Pump Flow Setpoint Based on Calibration Column Test (gal/hr).

5) Flow pacing with closed loop and analyzer trim algorithm:
   a) Operator selects a desired dose and desired analyzer setpoint band and the control system adjusts the speed of the chemical feeder through a speed control signal to match the measured chemical feed rate to a flow rate setpoint.
   b) An additional control algorithm is used in the calculation to fine-tune the feed based on an analytical measurement as measured by the process analyzer.

Use the following equation to calculate the chemical pump flow rate pre-trim:

$$Q_{CPT} = \frac{D \cdot Q_f \cdot 8.34}{C \cdot p \cdot 24}$$

Where:
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
D = Dose setpoint (mg/L)
Q_f = Process Flow Measurement (MGD)
8.34 = Conversion Factor [(lbs • L)/(MG • day • mg)]
C = Chemical Concentration (ratio in decimal format. For example, use 0.25 for 25 percent chemical solution)
p = Chemical Density (lbs/gal)
24 = Conversion Factor (days to hours)

Use the following equation to calculate the trim factor:

$$TF = Q_{CPT} \cdot 0.1 \cdot \left(\frac{AI - \frac{1}{2}(QAH + QAL)}{-\frac{1}{2}(QAH - QAL)} \right)$$

Where:
TF = Trim Factor (gal/hr)
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
AI = Analyzer Output to be Used For Trim Calculation
QAH = Analyzer Band High Value
QAL = Analyzer Band Low Value

Use the following equation to calculate the chemical pump flow rate with trim:

$$Q_{CWT} = Q_{CPT} + TF$$

Where:
Q_{CWT} = Chemical Pump Flow Rate with Trim (gal/hr)
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
TF = Trim Factor (gal/hr)

6) The speed (control variable) of the chemical feed pump shall be determined by the output of a PID controller.
   a) Setpoint of the PID controller shall be the result of the equation in the paragraph above.
   b) Process variable (feedback) shall be the chemical feed flow as measured by a flow meter on the discharge of the chemical feed pump.

20. Breaker status:
    a. Display the following data to the extent it is available from the specified device:
       1) Open.
       2) Closed.
       3) Tripped.
       4) Ground fault.
       5) Settings.
       6) Racked out.
21. Power data:
    a. Retrieve data from:
       1) Power quality meters (PQMs) at 480 V.
       2) Main breaker protective relays on 12.47 kV switchgear.
       3) Generator master control panel.
       4) Digital bus networks, as indicated.
       5) Where available, use EtherNet IP communications.
    b. Display the following data (to the extent it is available) from the specified device.
       1) Current XXXX.X A:
          a) A-Phase.
          b) B-Phase.
          c) C-Phase.

2) Volts: XXXX.X V:
    a) A-Phase.
    b) B-Phase.
    c) C-Phase.
3) Reactive power: XXXX.X kVAR.
4) Real power: XXXX.X kW.
5) Apparent power: XXXX.X kVA.
6) Power factor: 0.XX.
7) Energy: XXXXXXX kW*hr.
8) Demand peak: XXXX amp.
9) Demand peak: XXXX kW.

c. For engine/generator system monitoring, also display percent of rated output.

22. Power supply and distribution displays power quality meters display:
    a. In addition to the power data listed above, display the following (where available) from PQMs, protective relays, and generator master control panel:
        1) Frequency: Hertz.
        2) THD (current and voltage): Up to 31st harmonic.
    b. Calculate, indicate, historize, and trend data in a 12.47 kV meter table that lists measurements from the following protection relays:
        1) Protection Relay on 52-G1.
        2) Protection Relay on 52-G2.
        3) Protection Relay on 52-M1.
        4) Protection Relay on 52-M2.
        5) Protection Relay on 52-M3.
        6) Display calculated values for “Load At 12.47 kV”, which sums the current, kW, and kW-hr values for all 5 protection relays.
        7) Display calculated values for “Load At 480 V”, which sums the current, kW, and kW-hr values for all PQM meters.
        8) Display calculated values for “Transformer and Line Losses”, which subtracts “Load at 480 V” from “Load At 12.47 kV” for current, kW, and kW-hr values for all PQM meters.
    c. Display the data in a 480 V meter table that lists measurements from all power quality meters on the plant.
23. Digital bus starters, RVSS and VFDs equipped with EtherNet I/P communications:
    a. Communicate and display all values listed in the equipment specifications, indicated on the Drawings, or listed below.
    b. Communicate start and stop commands and receive running feedback over the fieldbus network.
    c. Provide data entry screen for the cost of electricity in dollars per (kw*hr), which will be used in calculations for display.
    d. Monitor the following additional values, and display on the HMI:
        1) Motor current, phase A, B, and C.
        2) Over current alarm.
        3) Under current alarm.
        4) Running status.
        5) Phase loss.
        6) Stall.
        7) Number of starts.
        8) History of past 5 trips.

e. Calculate, indicate, historize, and trend, the following additional values:
    1) Full Load Amps (static value; Engineer will provide).
    2) Average Motor Operating Current.
    3) Run Time (Hours).
    4) Operating Hours (Hours/Year).
    5) Average Load Factor (equals Average Motor Current Operating Current/Full Load Amps) - *display as a percentage.*
    6) Annual Energy Use (kW*hr).
    7) Annual Operating Cost (dollars).
    8) Percent of Site Electric Use (equals Annual Energy Use/Sum of Annual Energy (kW*hr) values for all PQM meters).
f. For variable frequency drives:
    1) Speed command.
    2) Speed feedback.
g. For RVSS, variable frequency drives, and where otherwise shown or available, monitor the following over the digital bus network:
    1) Line voltage.
    2) Power.
    3) Power factor.
    4) Over voltage alarm.
    5) Under voltage alarm.
    6) Over current alarm.
    7) Under current alarm.
    8) Indicate, historize, trend, and alarm data as indicated in the Digital I/O Tables on the Drawings.

24. Instruments equipped with digital bus communications:
    a. Communicate and display all values listed in the equipment specifications, indicated on the Drawings, or listed below:
        1) Instrument diagnostics.
        2) Communications health.
        3) Process variable.
        4) Alarm summary.
        5) All totalizers (if applicable).
        6) Indicate, historize, trend, and alarm data as indicated in the Digital I/O Tables on the Drawings.
25. Power failure:
    a. Retain all operating setpoints during power failure.
    b. Restore plant operation to the state it was before the power loss:
        1) Store the operating state of all major equipment and systems in the PLC and retain the last state during a power loss.
    c. Provide an operator selection to permit the plant to re-start. Once re-start is selected:
        1) Allow plant loads to re-start and allow loads to sequence on and ramp up following normal control logic. Where loads were operating in PCS MANUAL, restore their operation to the state before the power loss.
        2) Use the logic described above for preventing concurrent starts to provide necessary delays between each start.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning.

END OF SECTION

SECTION 40_61_16.10

SPECIFIC CONTROL STRATEGIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loop descriptions for all areas.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations:
   1. HSS: Hand speed switch.
   2. LCP: local control panel.
   3. LOR: local-off-remote.
   4. PCS: process control system.

C. Definitions:
   1. Loop description: Specific control requirements and functional descriptions for individual control loops.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Develop detailed loop descriptions based on the information in the Contract Documents:
   1. Submit loop descriptions with implemented modifications from this Section clearly marked.
   2. Remove all markings on final loop descriptions submitted with the applicable operation and maintenance manuals.

1.04 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 WAS PUMPS

A. General:
   1. References:
      a. 050N102.
   2. Key equipment:
      a. PMP-34033
      b. PMP-34034
   3. Abstract:
      a. Two WAS pumps are provided to transfer WAS from the secondary sludge pump station to the gravity belt thickeners or sludge storage tanks. The pumps operate in a DUTY/STANDBY configuration.

B. Hardwired controls:
   1. Pilot devices:
      a. LCP:
         1) LOR switch selector switch**,** Start and Stop pushbuttons:
            a) With the LOR in LOCAL the pump is controlled by the START and STOP pushbuttons.
               (1) The hand speed switch is used to adjust VFD speed when the LOR is in LOCAL.
            b) With the LOR in OFF, the pump is stopped.
            c) With the LOR in REMOTE, the pump is controlled by the PLC.
      b. Drive/starter enclosure:
         1) Standalone VFDs are provided for the WAS pumps.
   2. Interlocks:
      a. Drive/starter enclosure:
         1) Motor temperature high.
         2) VFD failed.
         3) High discharge pressure.
      b. When the pump is started, the actuator on the discharge of the pump is called to open.
   3. Indicators and alarms:
      a. Drive/starter enclosure:
         1) Running and failed lights.

C. PCS controls:
   1. Manual mode:
      a. Operators may manually start and stop the pump and adjust speed from SCADA.
   2. Auto mode:
      a. The pumps shall run in a DUTY/STANDBY configuration on an operator adjustable schedule. Pump speed is modulated by a PID controller to maintain the flow setpoint as measured by FIT-34000, where:
         1) PV = F-34000
         2) CV = pump speed
         3) SP = Flow setpoint

3. Indicators and alarms:
    a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
    b. Additional indicators and alarms:
        1) Motor temperature high.
        2) VFD failed.
        3) High discharge pressure.
        4) Flow (FIT-34000).
        5) TSS (AIT-34000).

3.02 SECONDARY CLARIFIER DEWATERING PUMP

A. General:
    1. References:
        a. 340N01
    2. Key equipment:
        a. PMP-33088
    3. Abstract:
        a. A dewatering pump is provided to transfer RAS from the secondary clarifiers to the RAS header.

B. Hardwired controls:
    1. Pilot devices:
        a. LCP:
            1) LOR switch selector switch**:**
                a) With the LOR in LOCAL the pump is controlled by the START and STOP pushbuttons.
                b) With the LOR in OFF, the pump is stopped.
                c) With the LOR in REMOTE, the pump is controlled by the PLC.
        b. Drive/starter enclosure:
            1) The FVNR for the dewatering pump is located in the MCC.
    2. Interlocks:
        a. Drive/starter enclosure:
            1) Low seal water flow.
            2) Low discharge flow.
            3) Motor overload.
            4) Motor temperature high.
    3. Indicators and alarms:
        a. Drive/starter enclosure:
            1) Running and failed lights.

C. PCS controls:
    1. Manual mode:
        a. Operators may manually start and stop the pump from SCADA.
    2. Auto mode:
        a. The dewatering pump shall run on an operator adjustable schedule.
    3. Indicators and alarms:
        a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
        b. Additional indicators and alarms:
            1) Low seal water flow.

2) Low pressure.
3) Motor high temperature.
4) Motor overload.
5) Failed alarm.

3.03 SLUDGE STORAGE PUMPS

A. General:
1. References:
a. 420N101.
b. 420N102.
2. Key equipment:
a. PMP-42001.
b. PMP-42004.
3. Abstract:
a. The sludge storage pumps are provided to transfer sludge from the solids storage tank to the gravity thickeners. The pumps operate in a LEAD/LAG configuration.
b. The pumps operate in one of two modes:
1) Centrifuge feed mode.
2) Gravity belt thickener feed mode.

B. Hardwired controls:
1. Pilot devices:
a. LCP:
1) LOR switch selector switch**:**
a) With the LOR in LOCAL the pump is controlled by the START and STOP pushbuttons.
b) With the LOR in OFF, the pump is stopped.
c) With the LOR in REMOTE, the pump is controlled by the PLC.
b. Drive/starter enclosure:
1) The VFDs for the pumps are in MCC-42001.
2. Interlocks:
a. Drive/starter enclosure:
1) Low suction pressure.
2) High discharge pressure.
3) VFD failed.
4) Motor temperature high.
b. Software interlocks:
1) Low sludge level in tank(s). See PCS controls hereinafter.
3. Indicators and alarms:
a. Drive/starter enclosure:
1) Running and failed lights.

C. PCS controls:
1. Manual mode:
a. Operators may manually start and stop the pump and adjust pump speed from SCADA.
b. Operators may manually energize either dilution water solenoid (SV-42001, SV-42002).

2. Auto mode:
    a. When a pump is running, the dilution water solenoid valves shall be energized based on timer setpoints input by the operator. These setpoints shall be entered as 0 minutes (0.0 - 5.0 minutes, default 0) per 5 minute cycles that the valve is open while the pump is running.
    b. Operators will select 1, 2, or both sludge storage tanks in service, and operators will designate which pump is feeding each tank. Manual valves must be adjusted to allow feed from the proper tank(s).
        1) This selection shall be used to determine which sludge storage tank's level transmitter is used for the low level software interlock with the pumps.
    c. Operators will designate whether the sludge storage pumps are feeding the Centrifuge or the GBT. The pumps shall run to meet a pump discharge flow setpoint as monitored by FIT-42003. Provide a PID controller to control pump speed:
        1) PV = F-42003.
        2) CV = pump speed
        3) SP = flow setpoint (either Centrifuge flow setpoint or GBT flow setpoint)
            a) Centrifuge feed mode:
                (1) The pump shall start and stop when requested by the centrifuge control system via SCADA.
            b) GBT feed mode:
                (1) Operator-entered setpoint.
    d. Valves are automatically adjusted based on the mode selected.
        1) Centrifuge feed mode:
            a) EDR-53014 is closed.
            b) EDR-53015 position is not changed.
            c) EDR-53016 is open.
        2) GBT feed mode:
            a) Manual valve adjustments (VAL-05005) must be made prior to GBT feed mode. Provide a pop-up for operators to confirm manual adjustments have been made before GBT feed mode is enabled.
            b) EDR-53014 position is not changed.
            c) EDR-53015 position is not changed.
            d) EDR-53016 is closed.
3. Indicators and alarms:
    a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
    b. Additional indicators and alarms:
        1) Low suction pressure.
        2) High discharge pressure.
        3) VFD failed.
        4) Motor temperature high.
        5) High/low pump discharge flow.

3.04 THICKENED SLUDGE PUMPS

A. General:
   1. References:
      a. 530N102.
      b. 530N103.
   2. Key equipment:
      a. PMP-53061.
      b. PMP-53062.
   3. Abstract:
      a. The thickened sludge pumps are provided to transfer sludge from the existing thickened sludge tanks to the thickened sludge distribution piping. Valves may be manually adjusted to feed sludge to the gravity belt thickeners and dewatering centrifuges. The thickened sludge pumps operate in a DUTY/STANDBY configuration.
      b. The pumps may be operated in one of two modes:
         1) Sludge storage tank feed mode.
         2) Centrifuge feed mode.

B. Hardwired controls:
   1. Pilot devices:
      a. LCP:
         1) LOR switch selector switch**:**
            a) With the LOR in LOCAL the pump is controlled by the START and STOP pushbuttons.
            b) With the LOR in OFF, the pump is stopped.
            c) With the LOR in REMOTE, the pump is controlled by the PLC.
      b. Drive/starter enclosure:
         1) Standalone VFDs are provided for the thickened sludge pumps.
   2. Interlocks:
      a. Drive/starter enclosure:
         1) High discharge pressure.
         2) VFD failed.
         3) Motor temperature high.
      b. Software interlocks:
         1) Sludge storage tank high level.
   3. Indicators and alarms:
      a. Drive/starter enclosure:
         1) Running and failed lights.

C. PCS controls:
   1. Manual mode:
      a. Operators may manually start and stop the pump and adjust pump speed from SCADA.
   2. Auto mode:
      a. Operators will select 1, 2, or both sludge storage tanks in service. Manual valves must be adjusted to allow transfer to/from the proper tank(s). This selection shall be used to determine which sludge storage tank's level transmitter is used for the high level software interlock with the pumps.
         1) High level in the storage tank shall shut down the pump.

b. The pumps shall run to meet a pump discharge flow setpoint as monitored by FIT-53013. Provide a PID controller to control pump speed:
   1) PV = F-53013.
   2) CV = pump speed
   3) SP = flow setpoint (determined by mode).
c. Centrifuge feed mode:
   1) The pump shall start and stop when requested by the centrifuge control system via SCADA.
d. Sludge storage tank feed mode:
   1) The pumps operate at the operator-entered sludge storage feed tank mode flow setpoint. The pumps automatically stop when high level is reached in the selected sludge storage tank.
   2) The pump stop when low level is reached in the thickened sludge tank (existing signal).
e. Valves are automatically adjusted based on the mode selected.
   1) Centrifuge feed mode:
      a) EDR-53014 is opened.
      b) EDR-53015 is closed.
      c) EDR-53016 is closed.
   2) Sludge storage tank feed mode:
      a) EDR-53014 is closed.
      b) EDR-53015 is opened.
      c) EDR-53016 position is not changed.
f. Sludge density meter flushing solenoid (SV-53011):
   1) The solenoid shall be energized for 0-120 seconds every 5-9999 minutes, operator adjustable. Hold the density signal at last value during a flushing operation.

3. Indicators and alarms:
   a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
   b. Additional indicators and alarms:
      1) High discharge pressure.
      2) VFD failed.
      3) Motor temperature high.
      4) High/low pump discharge flow.
      5) Sludge density: generate an alarm when sludge density exceeds the operator setpoint, initially set to 6%.

3.05 SUMP PUMPS

A. General:
   1. References:
      a. 420N801.
      b. 530N801.
   2. Key equipment:
      a. PMP-42010.
      b. PMP-42011.
      c. PMP-53020.
      d. PMP-53021.

3. Abstract:
    a. Duplex sump pumps are provided to transfer waste flows to the plant drain.

B. Hardwired controls:
1. Pilot devices:
    1) VCP: Pumps may be manually started and stopped from the VCP.
2. Interlocks:
    a. VCP:
        1) The pumps operate on a LEAD/LAG basis to maintain level in the sump below high level.
3. Indicators and alarms:
    a. Drive/starter enclosure:
        1) Running and failed lights.

C. PCS controls:
1. Manual mode:
    a. None.
2. Auto mode:
    a. None.
3. Indicators and alarms:
    a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
    b. Additional indicators and alarms:
        1) Pump running.
        2) Pump failed.
        3) Sump high level.

3.06 SLUDGE STORAGE TANKS

A. General:
1. References:
    a. 440N101.
    b. 440N102.
2. Key equipment:
    a. MIX-44001.
    b. SV-44001.
    c. MIX-44004.
    d. SV-44004.
    e. LIT-44001, LSH-44002: Sludge storage tank 1.
    f. LIT-44004, LSH-44005: Sludge storage tank 2.
    g. Dilution water solenoids:
        1) SV-44001 for sludge storage tank 1.
        2) SV-44002 for sludge storage tank 2.
3. Abstract:
    a. Two new sludge storage tanks are provided for sludge storage prior to delivery to the gravity belt thickeners and centrifuges.

B. Hardwired controls:
    1. Pilot devices:
        a. LCP:
            1) LOR switch selector switch**:**
                a) With the LOR in LOCAL the pump is controlled by the START and STOP pushbuttons.
                b) With the LOR in OFF, the pump is stopped.
                c) With the LOR in REMOTE, the pump is controlled by the PLC.
        b. Drive/starter enclosure:
            1) The VFD is installed in MCC-42001.
    2. Interlocks:
        a. Drive/starter enclosure:
            1) VFD failed.
            2) Motor temperature high.
        b. Software interlocks:
            1) Sludge storage tank low level.
            2) Sludge storage tank high level (LSH or LIT).
            3) High mixer motor temperature or VFD failed shall trigger the dilution water solenoid to energize and run based on the cycle timer as described in PCS controls hereinafter.
            4) High discharge pressure (P-42002 for pump 1, P-42005 for pump 2) shall trigger the dilution water solenoid to energize and run based on the cycle timer as described in PCS controls hereinafter.
                a) Operators shall enter a high pressure dilution setpoint to energize the dilution water solenoids.
    3. Indicators and alarms:
        a. MCC:
            1) Running and failed lights for tank mixer.

C. PCS controls:
    1. Manual mode:
        a. Operators may manually start and stop the mixer and adjust mixer speed from SCADA.
        b. Operators may manually energize the dilution water solenoids.
    2. Auto mode:
        a. The mixer shall run when tank level is above the mixer start setpoint and stop when tank level falls below the mixer stop setpoint.
            1) Disallow entry of a mixer start setpoint if it is below the current stop setpoint.
        b. W3 solenoids:
            1) Operators may select enable or disable for dilution water. When enabled, the dilution water solenoid shall open for an operator-entered adjustable duration, X minutes for every 10 minutes.
    3. Indicators and alarms:
        a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
        b. Additional indicators and alarms:
            1) VFD failed.
            2) Motor temperature high.

3.07 EXISTING THICKENED SLUDGE STORAGE TANKS

A. General:
   1. References:
      a. 530N101.
   2. Key equipment:
      a. Dilution water solenoids:
         1) SV-53001 for thickened sludge storage tank 1.
         2) SV-53002 for thickened sludge storage tank 2.
   3. Abstract:
      a. Two new dilution water solenoids are provided to allow operators to dilute the contents of each thickened sludge tank.

B. Hardwired controls:
   1. Pilot devices: None.
   2. Interlocks:
      a. Software interlocks:
         1) High discharge pressure (P-53061 for pump 1, P-53062 for pump 2) shall trigger the dilution water solenoid to energize and run based on the cycle timer as described in PCS controls hereinafter.
            a) Operators shall enter a high pressure dilution setpoint to energize the dilution water solenoids.
   3. Indicators and alarms:
         1) Existing controls.

C. PCS controls:
   1. Manual mode:
      a. Operators may manually energize the solenoids from SCADA.
   2. Auto mode:
      a. Operators will select which thickened sludge storage tanks are in service for the purpose of controlling the dilution water valves.
      b. Dilution water solenoid valves:
         1) Operators may select enable or disable for dilution water. When enabled, the dilution water solenoid shall open for an operator-entered adjustable duration, X minutes for every 10 minutes.
   3. Indicators and alarms:
      a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
      b. Additional indicators and alarms: None.

3.08 INLINE POLYMER MIXER

A. General:
   1. References:
      a. 530N104.
   2. Key equipment:
      a. MIX-53012.
      b. LCP-53012.
   3. Abstract:
      a. A new polymer mixer is provided to mix polymer prior to delivery to the dewatering centrifuges.

B. Hardwired controls:
    1. Pilot devices:
        a. LCP:
            1) When the LOR selector switch is in LOCAL, the mixer is controlled by START and STOP pushbuttons.
            2) When the LOR selector switch is in the OFF position, the mixer is stopped.
            3) When the LOR selector switch is in REMOTE, the mixer is controlled by SCADA.
    2. Interlocks: VFD failed or high motor temperature shall stop the mixer.
    3. Indicators and alarms: running and failed pilot lights.

C. PCS controls:
    1. Manual mode:
        a. Operators may manually start and stop the mixer and adjust mixer speed from SCADA.
    2. Auto mode:
        a. Operators shall select which set of pumps is feeding sludge to the mixer. Provide a PID controller to modulate mixer speed to maintain an operator entered flow setpoint:
            1) PV = F-42003 or F-53013
            2) CV = mixer speed
            3) SP = Flow setpoint
    3. Indicators and alarms:
        a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
        b. Additional indicators and alarms:
            1) Running status
            2) Failed alarm.
            3) Speed indication.
            4) Motor temperature high.

3.09 HVAC AND GO/NO-GO SYSTEM

A. General:
    1. References:
        a. 420N802.
        b. 420N803.
    2. Key equipment:
        a. EF-42032.
        b. SF-42033.
        c. AHU/CDU-42030.
        d. AHU/CDU-42031.
        e. TIT-42033.
        f. LCP-42021.
    3. Abstract:
        a. Air handling units, condensing units, and supply and exhaust fans are provided for building supply air. Room temperature is monitored.

B. Hardwired controls:
    1. Pilot devices:
        a. MCC:
            1) Exhaust and supply fans: LOR switch selector switch**:**
                a) With the LOR in LOCAL the pump is controlled by the START and STOP pushbuttons.
                b) With the LOR in OFF, the pump is stopped.
                c) With the LOR in REMOTE, the pump is controlled by the PLC.
        b. Go/No-go panel LCP-42021:
            1) The Silence and Reset pushbuttons on the LCP are used to silence and reset alarms once fans are running.
    2. Interlocks:
        a. Low current indicating loss of running status is hardwired to the go/no-go panel to indicate a failure of the supply fan or the exhaust fan.
        b. The go/no-go panel energizes the go beacons when all fans are running. The go/no-go panel energizes the no-go beacons when the current switch signal is lost.
    3. Indicators and alarms:
        a. Exhaust and supply fans:
            1) Running and failed pilot lights.

C. PCS controls:
    1. Manual mode:
        a. Exhaust and supply fans:
            1) Operators may manually start or stop the fans from SCADA.
    2. Auto mode: N/A.
    3. Indicators and alarms:
        a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
        b. Additional indicators and alarms:
            1) Running status
            2) Failed alarm.
            3) Low current.
            4) Room temperature.

3.10 ODOR CONTROL SYSTEM

A. General:
    1. References: 440N801.
    2. Key equipment: VCP-44020.
    3. Abstract:
        a. The odor control fan will draw foul air from the sludge storage tanks and septic receiving station.
        b. The odor control fan shall be started and stopped manually or automatically. When operating fan shall run continuously.
        c. The entire odor control system shall be controlled and powered through the manufacturer provide vendor control panel, VCP-44020.
        d. The biotrickling filter shall be used to remove odorous compounds from air drawn from the flow equalization basin and septic receiving station.

B. Hardwired controls:
   1. Pilot devices: As specified in Section 46_78_83 - Packaged Biotrickling Filter Odor Control System.
   2. Interlocks: All interlocks are internal to VCP.
   3. Indicators and alarms: As specified in Section 46_78_83 - Packaged Biotrickling Filter Odor Control System.

C. PCS controls:
   1. Manual mode:
      a. Operators may manually start or stop the odor control system from SCADA.
   2. Auto mode: The odor control system is running under normal operation. All controls are internal to the VCP.
   3. Indicators and alarms:
      a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
      b. Additional indicators and alarms:
         1) Running status
         2) Failed alarm.
         3) LOR in REMOTE.
         4) Auto status.

3.11 SLUDGE DENSITY METER FLUSHING

A. General:
   1. References: 530N104.
   2. Key equipment: SV-53011.
   3. Abstract:
      a. Solenoid valves opens/closes to perform a (heated) water flushing of the sludge density meter.

B. Hardwired controls:
   1. Interlocks: None.
   2. Indicators and alarms: None.

C. PCS controls:
   1. Manual mode:
      a. Operators may manually open/close the solenoid valve from SCADA.
   2. Auto mode:
      a. Operators select a duration of flush (5 to 60 sec, default 30) and frequency (30 to 120 minutes, default 60) of flush cycles. Flushing occurs automatically by opening the valve for the duration, closes, and then delays the next flushing cycle for the frequency delay timer duration.
      b. The flushing cycle can be elected to be “always on” or “only when pumping”.
         1) Always On mode will flush the density meter as indicated with the flushing duration and cycle.
         2) When Pumping mode will flush the density meter only if the flow meter (FIT-53013) is reading a flow above setpoint min flow (15 to 100 gpm, default 25) by following the flush cycle. If the flow minimum

is not met, the solenoid will close and frequency delay timer will reset.

3. Indicators and alarms:
   a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
   b. Additional indicators and alarms:
      1) None.

3.12 TESTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

END OF SECTION

SECTION 40_64_01

CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Programmable logic controller (PLC) based control systems hardware.
   2. Development software to be used with the specified PLC hardware.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations:
   1. CPU: Central processing unit.
   2. I/O: Input/Output.

C. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Application software: Software that is programmed specifically for the Project.
   2. Development operating software: Software provided by the PLC manufacturer for use in programming the PLC.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. CPU:
      a. Processor type.
      b. Processor speed.
      c. Memory.
      d. Internal processor battery backup time.
   2. I/O modules:
      a. Type.
      b. Standard wiring diagram.
   3. Programming languages.
   4. Operating system requirements.

C. Calculations:
   1. Calculations or documented estimate to verify that memory requirements of this Section are met, including spare requirements. If possible, use the PLC manufacturer's calculation or estimating worksheet.
   2. Calculations to verify that spare I/O requirements of this Section are met.
   3. Calculations to verify that PLC power supply requirements of this Section are met.

D. Control logic:
   1. Fully annotated copy of programmed PLC logic.
   2. Cross-referenced index of PLC registers or points.

E. Provide application software for the specific Project process requirements:
   1. Fully annotated copy of programmed PLC logic in its native format.
   2. Cross-referenced index of PLC registers or points.

1.05 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish the following:
   1. CPU: 1 spare for each type of CPU in the system.
   2. I/O cards: 3 spares for each type of I/O card in the system.
   3. Power supplies: 2 spares for every power supply in the system.
   4. Network/communications cards: 1 spare for every network or communications card in the system.
   5. Remote adapter: 1 spare for every remote adaptor in the system.
   6. Chassis: 1 spare for each chassis size in the system.
   7. Communication cable: 1 spare for each type of cable used in the system.

B. Installed spare requirements:
   1. I/O points:
      a. Provide total of 25 percent spare I/O capacity for each type of I/O at every PLC/RIO rack using the following calculation:

$$\left(1 - \frac{\text{UTILIZED IO POINT COUNT}}{\text{TOTAL IO POINT COUNT}}\right) * 100 = \%\text{SPARE}$$

      b. Wire spare I/O points to field terminal blocks in the same enclosure the PLC/RIO resides in.
   2. PLC backplane capacity:
      a. Provide 25 percent or 3 spare backplane slots, whichever is greater, in racks containing I/O.
   3. PLC memory:
      a. Provide 50-percent spare program volatile memory.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PLC hardware as indicated on the Drawings and as specified in this Section.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide PLC system components by a single manufacturer:
   1. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.

B. Use PLC manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.

C. PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects, and produced by manufacturers regularly engaged in the manufacture of these products.

D. Wherever possible, use the same model of each PLC module type throughout the Project.
   1. Provide redundant PLC processors for PLC-420.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Rockwell Automation:
      a. CompactLogix 5370, 1769-L3 Series.
      b. ControlLogix 5580, 1756-L72 Series, software version 30.
      c. Flex I/O, 1794 Series.

B. PLC programming software system shall be manufactured by PLC hardware manufacturer:
   1. Rockwell Software:
      a. Studio 5000.

2.04 MANUFACTURED UNITS

A. Programmable logic controller:
   1. Construction:
      a. Furnish plug-in modular system.
      b. Capable of operating in a hostile industrial environment without fans, air conditioning, or electrical filtering:
         1) Temperature: 0 to 55 degrees Celsius.
         2) RFI: 80 to 1,000 MHz.
         3) Vibration: 10 to 500 hertz.
         4) Humidity: 0 to 95 percent.
      c. Provide internal power supplies designed to protect against overvoltage and frequency distortion characteristics frequently encountered with the local power utility.
      d. Design the PLC system to function as a standalone unit that performs all of the control functions described in this Section completely independent from the functions of the HMI system PC-based operator interfaces:
         1) Failure of the HMI system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
   2. CPU:
      a. Configure each CPU so that it contains the software relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions.
      b. Capable of interfacing with discrete inputs, analog inputs, discrete outputs, analog outputs, and communication cards to meet the specified requirements.
      c. Capable of supporting and implementing closed-loop floating-point math and PID control that is directly integrated into the CPU control program.
   3. Memory:
      a. Supply with sufficient memory to implement the specified control functions plus a reserve capacity as specified with the requirements of this Section:
         1) Reserve capacity:
            a) Totally free from any system use.
         2) Programmed in a multi-mode configuration with multiple series or parallel contacts, function blocks, counters, timers, and arithmetic functions.
   4. Programming:
      a. Provide a system where processors are programmed by:
         1) Portable laptop computer both locally and via the PLC control network.
   5. PLC power supply:
      a. Input: 120 VAC.
      b. Mounted in the PLC housing or as indicated on the Drawings.
      c. Sized to power modules mounted in that housing, including an average module load for any empty housing slots, plus 50 percent above that total.
   6. PLC input/output, I/O modules:
      a. General:
         1) Compatible with all PLCs being furnished under the Contract and by the same manufacturer as the PLCs.

2) Provide I/O modules that:
    a) Isolate in accordance with IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
    b) Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
    c) Accept dual-ended inputs.
3) Use of common grounds between I/O points for modules that require individual isolation is not acceptable.
4) Provide modules that are removable without having to disconnect wiring terminals:
    a) Utilize a swing-arm or plug-in wiring connector.
5) Provide at each PLC the I/O modules for the following:
    a) Designated future I/O points contained in the I/O lists and/or shown on the P&IDs, control schematics, or described in the control strategies.
    b) Installed spare capacity in accordance with the requirements of this Section.
    c) Wire spares provided to the field terminal strip.
6) Condition, filter, and check input signals for instrument limit conditions.
7) Filter, scale, and linearize the raw signal into an engineering-units-based measurement.
8) Alarm measurements for high, low, rate-of-change limits, and alarm trends.
9) Provide external fuses mounted on the field connection terminal block for discrete input, discrete output, and analog input I/O points.
10) When multiple cards of the same I/O type are provided and parallel equipment, instrumentation, or redundant processes exist, distribute I/O among cards to ensure that a single card failure will not render an entire process unavailable.

b. Discrete input modules:
    1) Defined as contact closure inputs from devices external to the input module.
    2) Provide inputs that are optically isolated from low-energy common-mode transients to 1,500 volts peak from users wiring or other I/O modules.
    3) With LEDs to indicate status of each discrete input.
    4) Input voltage: 120VAC.
    5) Provide input module points that are individually fused with blown-fuse indicator lights, mounted external of the module on the output terminal strip:
        a) Coordinate external fuse size with the protection located on the module so that the external fuse opens first under a fault condition.

c. Discrete output modules:
    1) Defined as contact closure outputs for ON/OFF operation of devices external to the output module:
        a) Triac outputs may be used, with the permission of the Engineer. Care must be used in applying this type of module to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.

2) Optically isolated from inductively generated, normal mode and low-energy common-mode transients to 1,500 volts peak.
3) LEDs to indicate status of each output point.
4) Output voltage: 120VAC.

d. Analog input modules: individually isolated.
1) Signal type: Provide 4 to 20 mA for most applications; other levels are acceptable to interface to vendor control panels.
2) Analog-to-digital conversion: Minimum 12-bit precision with the digital result entered into the processor.
3) Analog-to-digital conversion updated with each scan of the processor.
4) Individually isolated each input.
5) Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.
6) Provide field mounted surge suppression modules for analog signals that are located outside the building that houses the PLC node:
a) Manufacturers: One of the following or equal:
(1) Emerson/Edco, model SS65-036-2, or similar for loop powered field instruments.
(2) Emerson, model 265 (SLAC) series.
(3) Phoenix Contact, PLUGTRAB SEC series, or similar for field instruments that require auxiliary power (24 VDC/VAC, 120 VAC, 230 VAC).

e. Analog output modules:
1) Signal type: Provide 4 to 20 mA for most applications; other levels are acceptable to interface to vendor control panels.
2) Individual isolated output points each rated for loads of up to 1,000 ohms.

7. Communications modules:
a. Remote I/O adapter module:
1) For any PLC location requiring more than 1 housing to mount all of the I/O modules or that is identified as a RIO, provide the appropriate remote I/O adapter module for communication with the secondary housing(s).
2) Install the RIO adapter module in the PLC backplane and the RIO backplane.
3) Provide adapter modules that support all available types of I/O modules required.
4) Provide network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.
5) Complete diagnostic LEDs.

b. Network communications modules:
1) General:
a) Install communications modules in the PLC backplane.
2) Ethernet:
a) Ports: 1 RJ-45.
b) Communication rate: 100] Mbit/s.
c) Allen-Bradley ControlLogix - 1756-EN2T.
3) Provide network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.

8. PLC backplane housing:
    a. Mount the PLC power supply, CPU, communications module, and I/O modules in a suitable standard PLC backplane or housing.
    b. Provide spare slots in each PLC and RIO location in accordance with the requirements of this Section.
    c. Provide a blank slot filler module for each spare slot.

B. PLC programming software:
1. Furnish operating software capable of monitoring and/or controlling the PLCs via the PLC data network:
    a. Contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.
    b. Monitor devices at each drop on the PLC data network for proper communications.
    c. Provide the ability to program PLCs on the PLC data network from the Engineer's console.
2. PLC programming laptop/desktop operating system:
    a. Microsoft Windows 10.
3. Suitable for the PLCs specified above.
4. For programming, monitoring, searching, and editing:
    a. Usable both on-line, while connected to the PLC, and off-line.
    b. Operating software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical function blocks.
    c. Capable of disabling/forcing inputs, outputs, and coils to simulate the elements of the ladder logic; forced elements shall be identifiable by means of color change.
    d. Include a search capability to locate any address or element and its program location.
    e. Display at the EC, PLC status information, such as faults and communication errors and amount of memory remaining.
5. Support IEC-61131-3 compliant programming languages:
6. Generate a PLC program printout, which is fully documented, through the PLC programming software:
    a. Fully documented program listings include, as a minimum, appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes on an individual line-by-line basis.
    b. Include a sufficient embedded comment for every rung of the program explaining the control function accomplished in said rung.
    c. Use a mnemonic associated with each contact, coil, etc., that describes its function.
    d. Utilize the tag and loop identification as contained in the P&IDs:
        1) If additional internal coils, timers, etc., are used for a loop, they shall contain the loop number.
    e. Provide a cross-reference report of program addresses.
7. Software functions automatically without operator intervention, except as required to establish file names and similar information:
    a. Furnish the operating system software that is the standard uncorrupted product of the PLC manufacturer with the following minimum functions:
        1) Respond to demands from a program request.

2) Dynamic allocation of the resources available in the PLC. These resources include main memory usage, computation time, peripheral usage, and I/O channel usage.
3) Allotment of system resources based on task priority levels such that a logical allocation of resources and suitable response times are ensured.
4) Queuing of requests in order of priority if one or more requested resources are unavailable.
5) Resolution of contending requests for the same resource in accordance with priority.
6) Service requests for execution of 1 program by another.
7) Transfer data between programs as requested.
8) Management of information transfers to and from peripheral devices.
9) Control and recovery from program fault conditions.
10) Diagnose and report real-time hardware device errors.

8. Program execution:
   a. Application software - program execution scheduled on a priority basis:
      1) A multilevel priority interrupt structure is required.
      2) Enter into a list of pending programs a program interrupted by a higher priority program:
         a) Resume its execution once it becomes the currently highest priority program.
      3) Schedule periodic programs.
      4) Base the allocation of resources to a time-scheduled program on its relative priority and the availability of resources.
9. Start-up and restart:
   a. Provide software that initializes and brings a PLC or any microprocessor-based hardware unit from an inactive condition to a state of operational readiness.
   b. Initialization:
      1) Determination of system status before start-up of initializing operating system software and initializing application software.
      2) Loading of memory-resident software, initializing timers, counters, and queues, and initialization of dynamic database values.
10. Shutdown:
   a. Where possible, provide orderly shutdown capability for shutdowns resulting from equipment failure, including other PLC processor failures, primary power failure, or a manually entered shutdown command.
   b. Upon loss of primary power, a high-priority hardware interrupt initiates software for an immediate, orderly shutdown.
   c. Hardware is quickly and automatically commanded to a secure state in response to shutdown command or malfunction.
   d. Alarm PLC failure at the operator interface level.
11. Diagnostics:
   a. Furnish diagnostic programs with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
   b. Use the manufacturer’s standard diagnostic routines as much as possible.
   c. Furnish diagnostic software and test programs for each significant component in the control system.
   d. As a minimum, provide diagnostic routines to test for power supply, central processing unit, memory, communications, and I/O bus failures.

12. Calendar/time program:
    a. To update the second, minute, hour, day, month, and year and transfer accurate time and date information to system-level and application software.
    b. Variations in the number of days in each month and in leap years must be handled automatically by the program.
    c. Operator must be able to set or correct the time and date from any operator interface, only at the highest security level.
13. Algorithms:
    a. Implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
    b. Algorithms must be capable of outputting positional or incremental control outputs or providing the product of calculations.
    c. Algorithms must include alarm checks where appropriate.
    d. Provide, as a minimum, the following types of algorithms:
        1) Performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
        2) A switch algorithm, which reads the current and value from its input address and stores it as the value of its output address. 2 types of switches shall be accommodated: 2 outputs with 1 input and 1 output with 2 inputs.
        3) A 3-mode proportional-integral-derivative, PID, controller algorithm, with each of the 3 modes independently adjustable, supports both direct and reverse-acting modes.
        4) Lead, lag, dead time, and ratio compensators.
        5) Integration and totalization of analog process variables.
14. Furnish a comprehensive database for the analog inputs, calculated values, control modules, and outputs:
    a. In addition, provide spare database points for future expansion.
15. One integrated database can be utilized for all types of analog points or separate databases for each type; in either case, the database for each point must include all specified aspects.
16. All portions of the database must be available for use by the display, report, and other specified software modules.
17. Data fields and functions specified below must be part of the point definition database at the operator interface. Provide the capability to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification must include all features and functions defined below. Analog database software must support the following functions and attributes:
    a. Analog input signal types:
        1) Provide software at the remote terminal units (RTUs) and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.
    b. Input accuracy:
        1) Inputs must be read with an accuracy of within 0.05-percent full-scale or better.
        2) Data conversion errors must be less than 0.05-percent full-scale.

3) Pulse accumulation error less than or equal to 1 count of actual input count at a scan rate of once per minute.
4) Maintain for a minimum of 1 year the system accuracy stated above without adjustments.

c. Blocking:
1) Provide mechanisms to inhibit or block the scanning and/or processing of any analog input through the operator interface.
2) For any input so blocked, the operator may manually enter a value to be used as the input value.

d. Filtering:
1) For each analog input, provide a first order lag digital filter with an adjustable filter factor.

e. Linearizing:
1) Where analog inputs require square root extraction or other linearization, provide a mechanism to condition the filtered data before the process of scaling and zero suppression takes place.

f. Calculated values:
1) Provide means to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated values, constants, etc.
2) These values must be handled the same as real inputs in terms of record-keeping, alarming, etc.

g. Scaling and zero suppression:
1) Provide a conversion program to convert input values into engineering units in a floating-point format.

h. Alarms:
1) Provide an alarm program to check analog variables against high-high, high, low, and low-low alarm limits.
2) When an analog value exceeds a set limit, it must be reported as an alarm based on individually set priority level for each alarm point.
3) Provide an adjustable hysteresis band in order to prevent excessive alarms when a variable is hovering around an alarm limit.
4) Must be possible to inhibit alarms based on external events, e.g., lock-out low pump flow alarm when the pump is off.

i. Averages:
1) Provide a program to calculate and store hourly, daily, and monthly averages of analog variables.
2) Continuously compute averages, e.g., the average for the current period to the present point in time must be stored in memory and available for use in displays, etc.
3) Update hourly averages each minute or at the polling interval for the selected variable.
4) Update daily averages at least once each hour and calculate using the results of the hourly averages.
5) Update monthly averages at least once each day and calculate using the results of the daily averages.
6) At the end of each averaging period, store the average values for the period on the hard disk for historical record-keeping and reset the present period average register to the present value of the variable.
7) Active database must include the present period average and previous period average for each variable and averaging period.

j. Totals:
    1) Provide a program to calculate and store hourly, daily, and monthly totalization of analog variables.
    2) Assign a scaling factor to each variable to convert to the appropriate units based on a 1-minute totalizing interval.
    3) Assign a separate factor for each totalizing interval.
    4) Variables for which totalization is inappropriate must have scaling factors of zero.
    5) At the end of each totalizing period, store the totalized values for the period on the hard disk for historical record-keeping and reset the present period totalization register to zero.
    6) Active database must include the present period total and previous period total for each variable and totalizing period.
k. Engineering units:
    1) Provide software to allow the system and the operator to convert the measured analog variables to any desired engineering units.
    2) Operator must be able to view displays and generate reports of any measured variable in one or more engineering units, such as flow in gpm, mgd, cfs, and acre-feet per day.
    3) Pre-program the conversion of the engineering units, and, if not pre-programmed, the operator must be able to program new engineering unit conversions by using simple methods, e.g., multiplication of the database attributes by a constant.
    4) Programming method must be at a level and compatible with the specified training of the operator and the Owner's personnel.
    5) New conversions must not require the services of a special programmer and/or special, high-level, programming training.
l. Control modules:
    1) For each control function configured, whether processed at the RTU, PLC, or operator interface, maintain a file of necessary data, including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.
    2) Input and output assignments, setpoints, and constants must be adjustable by the operator through the operator interface.
    3) Provide control algorithms for manual control with output values adjustable by the operator.
m. Analog outputs:
    1) Analog outputs must be maintained as part of the database.
    2) These outputs must be adjustable manually by the operator through the operator interface or through automatic control algorithms.

18. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

C. General control functions:
1. Analog control functions:
    a. PID, lead/lag, signal select, alarm, limit, delay, and time base.
    b. Furnish the control system complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR, and NXOR functions.

c. Math utilities must be linkable to process data points or manual inputs via control block configuration.
d. By linking control blocks to data points, the math library must support system unit conversion and calculation requirements.

2. Discrete control functions:
   a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays, and time base.
3. Software support:
   a. Retain in firmware all control and logic functions at each RTU and PLC and in RAM at the operator interface.
   b. Call each function as required by the configured controls to perform the intended function.
4. Control and status discrepancies:
   a. Generate a discrepancy/fail alarm for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status:
      1) For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator-programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.
   b. Involuntary change in the device's status must also generate an alarm:
      1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.
   c. Each command, status, and alarm must cause the color of the symbol to change.
   d. Because many discrete final control elements have a cycle time in excess of the scan interval, provide each control output with an associated delay period selected to be longer than the operating period of the control element:
      1) Delay periods for each final control element must be adjustable at the operator interface.
      2) List time delays in the final documentation.
5. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

D. Control configuration:
1. Provide software to allow control strategies to be developed, and their operation initiated through the operator interface.
2. Provide standardized control point displays for defining the control functions, including the function type, input/output addresses, setpoints, tuning constants, etc.
3. Provide a mechanism to link separate control functions together into an integrated control strategy.
4. Provide a mechanism to download operational/control setpoints developed at any operator interface to any PLC or RTU for operational implementation.
5. Provide a mechanism to define and implement operational/control setpoints locally at the PLC or RTU, and to upload them to the operator interface for operational record-keeping.
6. Perform control configurations on-line at the operator interface; the PLC or RTU may be taken off-line when being configured or downloaded.

E. Remote inputs and outputs (RIOs):
   1. Compatible with all PLCs being furnished under this Contract, shall be by the same manufacturer as the PLCs, and, as a minimum, include:
      a. Power supply.
      b. Rack.
      c. Backplane.
      d. Communications module.
      e. I/O modules.
      f. Enclosure.
   2. Provide cables and software needed for a complete and operational RIO system as specified in the Contract Documents.
   3. Provide a group of pre-assigned diagnostic registers to report RIO system faults to the driver PLC.
   4. Control system must continue operation should a fault occur on a single RIO drop:
      a. Upon clearing the fault, restart communications to that drop automatically.

PART 3 EXECUTION

3.01 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies:
   1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.

C. All components of the control system, including data network cables, are the installation responsibility of the ICSC unless specifically noted otherwise.

D. Control system logic program shall reside at the PLC level.

E. Use the tag and loop identifications found on the P&IDs for all tags used and/or assigned as part of the application software work provided by the ICSC.

F. Program the PLC logic using the following language(s):
   1. Ladder Diagram.
   2. Function Block Diagram.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning.

B. Owner Training:
   1. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

END OF SECTION

SECTION 40_66_01

CONTROL SYSTEMS: NETWORK MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Materials and equipment used in process control and LAN networks, including:
      a. Network switches.
      b. Media converters.
      c. Routers.
      d. Patch panels and other data network hardware.
      e. Related accessories.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. Electronic Industries Alliance (EIA):
      a. 310-E - Cabinets, Racks, Panels, and Associated Equipment.
   2. Institute of Electrical and Electronics Engineers (IEEE):
      a. 802.1X - Standard for Local and Metropolitan Area Networks—Port-Based Network Access Control.
      b. 802.3 - Standard for Ethernet.
      c. 802.11b - Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher Speed Physical Layer (PHY) Extension in the 2.4 GHz band.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   4. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
   5. Telecommunications Industry Association (TIA):
      a. 569 - Telecommunications Pathways and Spaces.
      b. 607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
   6. Underwriters Laboratories, Inc. (UL).

1.03 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product data:
   1. Include information on all network equipment.
   2. Manufacturer's operation and installation instructions.

C. Shop Drawings:
   1. Complete set of drawings, including, but not limited to:
      a. System block diagram showing relationship and connections between devices provided under this Contract, including connections to any existing equipment.
      b. Include manufacturer and model information, and address settings.
      c. Network riser diagram.
      d. Network port diagram, which physically locates all ports within the facility, and identifies their patch panel and switch port.
      e. Construction drawings for equipment cabinets, including dimensions, identification of components, preparation and finish data, and nameplates.
      f. Electrical connection diagrams.
      g. Complete grounding requirements.
   2. Furnish data sheets for each component together with a technical product brochure or bulletin:
      a. Manufacturer's model number.
      b. Project equipment tag.
   3. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
      a. Quantity.
      b. Description.
      c. Manufacturer.
      d. Part numbers.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria.
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.

E. Calculations:
   1. Cooling calculations, including, but not limited to:
      a. Highest expected ambient temperature for the enclosure's location.
      b. Internal heat load.
      c. Exposure to direct sunlight.
      d. Dimensions of the enclosure in inches.
      e. Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

F. Test reports:
   1. As specified in Section 26_05_20 - Fiber Optic Cable and Appurtenances and Section 40_80_01 - Commissioning for Instrumentation and Controls.

2. Signed test results as described in this Section.
3. Test results shall include:
    a. Narrative describing the test procedures followed.
    b. Block diagram of test set up.
    c. Manufacturer's information on test equipment used.
    d. Detailed test results.
    e. A narrative summarizing the results of the testing and identifying any further action required.

G. Operating manuals:
1. Complete installation, operation, calibration, and testing manuals as specified in Section 01_75_17 - Commissioning.

H. Record drawings:
1. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.
2. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.05 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Vendor shall manufacture using low VOC-based materials to provide superior indoor air quality demonstrated by Greenguard certification.

B. Ethernet switches in LCP-42020 will be provided by the Owner.

C. Coordinate vendor-supplied Ethernet switches with the Owner's IT department for specific features and requirements during the submittal phase.

2.02 MANUFACTURERS

A. As listed below in the individual component paragraphs.

2.03 MANUFACTURED UNITS

A. Ethernet switches:
1. Managed process floor Ethernet switches:
a. Manufacturers: One of the following, or equal:
1) Cisco, IE3400.
b. Properties:
1) Hardware:
a) Power supply:
(1) Accepts redundant power feeds.
(a) Provide NEC Class 2 power circuit.
(b) 24 VDC, 100 VA maximum rating.
b) No fans or moving parts.
2) Performance:
a) Enclosure:
(1) All metal housing.
b) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes, but is not limited to:
(1) SNMP.
(2) VLAN.
(3) QoS.
(4) Port mirroring.
(5) DHCP server.
c) IGMP snooping with EtherNet/IP plug and play compatibility.
d) 802.1d, 802.1w, 802.1D RSTP.
3) Environment:
a) Operating temperature range: 32 to 140 degrees Fahrenheit.
b) Humidity: 10 to 95 percent, non-condensing.
4) Connections:
a) Copper: RJ-45.
(1) Auto-negotiating.
(2) Quantity: As required to provide network connections indicated on the Drawings, plus 20 percent spare.
b) Fiber: Gigabit SFP port.
(1) Quantity: As required to provide network connections indicated on the Drawings, minimum 2.
5) Mounting:
a) DIN-rail mounting.
2. Unmanaged Ethernet switches:
a. Manufacturers: One of the following or equal:
1) Antaira LNX-500A (5 port)
2) Antaira LNX 1600 (16 port)
b. Properties:
1) Hardware:
a) 10/100Tx
b) Power supply:
(1) Provide redundant power supplies.
(2) 24 VDC, 200 watts per power supply.
(3) Store and forward.
c) No fans or moving parts.

2) Performance:
    a) Full/half-duplex.
3) Environment:
    a) Operating temperature range: 32 to 140 degrees Fahrenheit.
    b) Humidity: 5 to 95 percent, non-condensing.
4) Ethernet switch shall be capable of performing basic switching without special programming or configurations.
5) Ports:
    a) As required to provide the number of connections required plus 10 percent spare of each type used.
6) Connector type:
    a) Copper: RJ-45.
7) Mounting:
    a) DIN rail.

B. Media converters:
1. Copper to fiber transceiver:
    a. Manufacturers: One of the following or equal:
        1) N-Tron.
        2) Phoenix Contact.
        3) Transition Networks.
    b. Used to convert Ethernet communication between copper and fiber optic cables:
        1) Match protocol, speed, and media of attached equipment.
        2) Meets requirements of IEEE 802.3 Ethernet standard.
        3) Connector type:
            a) Fiber: SFP.
            b) Copper: RJ-45.
        4) Power supply:
            a) 24 VDC.
        5) Mounting:
            a) DIN-rail mounting.
2. Copper to fiber transceiver:
    a. Manufacturers: The following, no equal:
        1) Phoenix Digital, Optical Communication Module for Ethernet Network.
            a) Used to connect a network device in a fiber optic ring connection.
            b) Fiber ports:
                (1) SFP.
                (2) Provide 4 spare SFP transceiver modules with each communication module.
    b. Ethernet port:
        1) 10/100BASE-T.
    c. Power:
        1) 120 VAC.

C. Patch panels:
1. Fiber optic patch panels:
    a. General:
        1) Optical fiber cables shall be provided with strain relief and terminated at a fiber patch panel. Final connections between the patch panel

and the fiber optic network equipment shall be made via factory tested fiber optic patch cords.
2) Fiber cable strands shall be terminated at the patch panels; no loose fiber strands are allowed.
3) Provide space for excess fiber and provide strain relief for the fiber cable.
4) Fiber cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out buffer tubes.
5) Fiber connectors: LC.

b. DIN-rail mounted:
1) Manufacturers: One of the following or equal:
a) Corning.
b) DINSpace, SNAP Cu.
c) Hirschmann, MIPP.
2) Properties:
a) Use for the termination of a single cable inside of cabinets, in small enclosures or as indicated on the plans.
b) DIN-rail mounted fiber patch panels shall be provided as a complete unit, including the housing, connector panels, splice trays, and fiber connectors.

2. Copper patch panels:
a. General:
1) Equipment and premises cables shall be terminated at a patch panel, except for field equipment connections.
2) Final connections between the patch panel and network equipment shall be by patch cords.
3) Provide factory tested copper patch cords as required to support network devices.
a) Provide 25 percent spare copper patch cords.
4) Cables shall be installed such that the outer sheath of the cable is carried into the patch panel before breaking out conductors.
5) Maintain twist of broken out conductors in accordance with TIA standards.
6) UL listed.
7) Properties:
a) Modular, all metal construction with built-in strain relief.
b) Compatible with both shielded and unshielded jack modules.
c) Patch panel and jack modules shall be by same manufacturer.
d) Utilizes jack modules for copper Ethernet cable termination.
e) Provided shielded jack modules with a 360-degree conductive path to ground as required by the installation. Install in accordance with the manufacturer’s recommendation.
f) Patch panel and jack modules shall meet or exceed category cable standard.
g) Jack module shall be capable of at least 20 termination cycles.
h) Provide 25 percent spare jack modules of each type.
8) Accessories:
a) Removable rear cable management bracket.
b) Rear individual port labels.

c) Front color-coded individual port labels.
d) Termination tool.

b. Manufacturers: One of the following or equal:
1) 19-inch rack mounted:
a) CommScope, SL series.
b) OCC, DCC series.
c) Panduit, Mini-Com series.
2) DIN-rail mounted:
a) DINSpace, SNAP XL.
b) OCC, DTC.

2.04 ACCESSORIES

A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.

B. Provide dust covers or plugs for unused ports.

C. Furnish accessories as specified in Section 40_62_14 - Control Systems: PCS Computer Equipment.

PART 3 EXECUTION

3.01 PREPARATION

A. Equipment support and anchoring to structures:
1. As specified in Section 01_81_50 - Design Criteria, including, but not limited to:
a. Anchor bolt layout.
b. Equipment templates.
c. Anchor installation.

3.02 INSTALLATION

A. Provide installation and configuration for the new and existing managed Ethernet switches. Provide configuration of the Ethernet switch network for a complete, functioning plant control system as indicated on the Drawings and as specified in this Section.
1. Refer to SCADA block diagrams for new network connections.
2. Provide configuration for managed Ethernet switches and other components, including, but not limited to, VLAN (virtual local area network), additional Plant PLC communication cards, and separate managed Ethernet switches as required, such that there is isolation of the following networks:
a. Remote I/O network: This includes the connections between the Plant PLC and:
1) Plant PLC expansion racks.
2) Plant PLC remote I/O (RIO) racks.

b. Field network: This includes the connections between the PLC and:
    1) Field devices.
    2) Vendor furnished Ethernet network components.
    3) Valve actuator network: This includes the connections between the PLC and the valve master stations.
c. PLC network: This includes the connections between the Plant PLCs and the I/O server(s).
d. Process control network: This includes the connections between the I/O server(s) and other equipment, including, but not limited to, servers, workstations, and printers.
e. Security control network: This includes any security hardware with Ethernet communication as provided by the security subcontractor.

3. Process floor managed Ethernet switches for the process control network shall be configured and programmed for rapid fail over protection.
4. Enterprise level managed Ethernet switches shall be configured for a communication protocol that is compatible with the process control network's rapid fail over protocol.

B. Work shall be performed in a neat and workmanlike manner.

C. Cable management:
1. Cables and equipment shall be installed in strict conformance with the manufacturer's recommendations.
2. Install cable using lubricant designed for cable pulling.
3. Install hook-and-loop wrap on all cable bundles within the network rack/enclosure. Plastic tie-wraps are not acceptable.
4. Install network cables without splices.
5. Installed bend radius shall be a minimum of 10 times the cable diameter.
6. Terminate pairs at the jack and patch panel.
7. Route cables through cable management or other form of containment. No loose, unsupported cables are permitted to span across network equipment.
8. Use corner strips to protect cables from edges inside ducts and to maintain bend radius requirements.

D. Cables and terminations shall be labeled with cable designations as specified in Section 26_05_53 - Identification for Electrical Systems.

E. Each data port shall be individually labeled with its patch panel/switch port ID:
1. Labeling must be printed. No handwritten labels will be allowed.

F. At the completion of the wiring installation, provide the following documentation:
1. A plan-view of the premise(s) showing the jack numbering scheme.
2. A printed certification report for the entire wiring installation showing compliance with TIA specifications for data cable.
3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.

G. Managed Ethernet switches:
1. Configure switches to prevent broadcast storms.
2. Installations shall employ IGMP snooping to limit multicast messaging.

3.03 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning.

B. Owner Training:
   1. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 ADJUSTING

A. Perform firmware installations, configuration, and other set up, as required, to place the network into proper operation.

END OF SECTION

SECTION 40_67_01

CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design, fabrication and assembly of instrumentation enclosures, control panels and components provided under this Contract, including, but not limited to:
      a. Custom built instrumentation and control panels, including enclosures for hand stations controllers, low voltage power distribution and marshalling panels.
      b. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCPs) and chemical feed panels.
      c. Control components.
      d. Control panel installation.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE):
      a. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits.
      b. 802.3af - Standard for Information Technology Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
      c. 802.3at - Standard for Information Technology -- Local and Metropolitan area networks -- Specific requirements -- Part 3: CSMA/CD Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements.
   2. International Electrotechnical Commission (IEC):
      a. 61643-11 - Low-Voltage Surge Protective Devices - Part 11: Surge Protective Devices Connected to Low-Voltage Power Systems - Requirements and test methods.
      b. 61643-21 - Low-Voltage Surge Protective Devices - Part 21: Surge Protective Devices Connected to Telecommunications and Signaling Networks - Performance Requirements and Testing Methods.
   3. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
   4. Underwriters Laboratories Inc. (UL):
      a. 248-14 - Low-Voltage Fuses - Part 14: Supplemental Fuses.

b. 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits.
c. 508 - Standard for Industrial Control Equipment.
d. 508A - Standard for Industrial Control Panel.
e. 698A - Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
f. 913 - Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations.
g. 1077 - Standard for Supplementary Protectors for Use in Electrical Equipment.
h. 1283 - Standard for Electromagnetic Interference Filters.
i. 1310 - Standard for Class 2 Power Units.
j. 1449 - Standard for Surge Protective Devices.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. The term “panel” in this Section is interchangeable with the term “enclosure.”

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Provide Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide a control panel hardware Submittal for each control panel/enclosure being provided on this Project, including, but not limited to:
   1. Product data:
      a. Enclosure construction details and NEMA type.
      b. Manufacturer’s literature and specification datasheets for each type of equipment to be installed within or on the panel or enclosure.
   2. Shop Drawings:
      a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
         1) Provide draft for review and approval by the Engineer. Engineer has the authority to substantially alter initial panel layouts.
      b. Complete nameplate engraving schedule.
      c. Structural details of fabricated panels.
   3. Calculations:
      a. Cooling calculations, including, but not limited to:
         1) Highest expected ambient temperature for the enclosure’s location.
         2) Internal heat load.
         3) Exposure to direct sunlight.

4) Dimensions of the enclosure in inches.
5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

C. Delegated Design Submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria:
a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
b. For equipment installed outdoors.
c. For wall mounted equipment weighing 125 pounds or more.

1.06 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Assemble panels, enclosures, and rack systems along with internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:
1. Provide components and equipment with UL 508 listing.
2. Control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the Contract Documents cannot be reasonably modified to meet the requirements for UL 508A labeling:
3. Provide fuses for equipment that is not UL or UR listed.
4. Install intrinsically safe circuits and equipment in accordance with UL 698A.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide control panels identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Panel dimensions:
   1. Minimum dimensions are scalable from or as indicated on the Drawings and are based upon manufacturer's non-certified information. It is the responsibility of the Contractor or manufacturer to design and size panels:
      a. Size panels to provide space for equipment, wiring, terminations, and other items in the panel, including 20 percent of the total back panel area shall remain empty.
      b. Panel sizes that substantially deviate (within 3 inches in any dimension) from the sizes indicated on the Drawings must be approved by the Engineer.
      c. Maximum panel depth: 32 inches, unless otherwise indicated.

B. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01_81_50 - Design Criteria and as indicated on the Drawings.

C. Non-conditioned spaces and outdoor installations:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

D. As listed below in the individual component paragraphs.
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.

2.03 EXISTING PRODUCTS

A. Provide labor and materials for complete modifications to existing panels as required.

B. Field cut and refinish existing panel faces to original condition to accommodate installation of new instruments, removal of existing instruments, and fitting of blanks to suit new layouts. New instrument supports shall be provided as required for complete installation.

2.04 MATERIALS

A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:
   1. Enclosures shall have the following properties:
      a. NEMA Type 1: Steel.
      b. NEMA Type 4: Steel with gasketed door, raintight.
      c. NEMA Type 4X: Type 316 stainless steel (unless Type 304 is indicated on the Drawings).
      d. NEMA Type 4X: Polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas where stainless steel is incompatible.

e. NEMA Type 12: Steel with gasketed door, dusttight.
f. NEMA Type 7: Cast aluminum.

B. Bolting material:
1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.
2. Carriage bolts for attaching end plates.
3. Other bolted joints shall have S.A.E. standard lock washers.

2.05 MANUFACTURED UNITS

A. Panels/enclosures:
1. Manufacturers: One of the following or equal:
a. nVent/Hoffman.
b. Rittal.
c. Saginaw Control & Engineering.
2. Panel assembly:
a. General guidelines for panel fabrication include:
1) Continuous welds ground smooth.
2) Exposed surfaces free of burrs and sharp edges.
3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2-inch holes at 12-inch spacing to accommodate anchoring of freestanding enclosures to floor.
b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	14	14
Up to 57	12	12
57 to 69	12	10
69 to 82	12, except 10 on back	10
82 or more	10	10

1) Use heavier sheet metal to meet seismic requirements at the Project Site or when required due to equipment requirements.
c. For Rittal or engineer-approved equal free-standing modular enclosure, construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	16	14
Up to 57	14	13
57 or more	16	11

d. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.
e. Provide stiffeners for back mounting or C folded back panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.
f. Door construction:
    1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
    2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
    3) Heavy-gauge stainless steel hinges.
    4) For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
    5) Gasket installed to seal against roll lip on the enclosure opening.
g. Latches:
    1) For panels, provide each door with an oil tight 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.
        a) Provide padlock for each enclosure with padlock provisions.
        b) Provide 2 keys per panel.
        c) All locks keyed alike.
    2) For Rittal or engineer-approved equal free-standing modular enclosure, provide each door with a 4-point latching mechanism, if available, or a 2-point latching mechanism if a 4-point is not available.
    3) For cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.
h. Panel cut-outs:
    1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
    2) Allow a minimum of 3-inch envelope around displays, controllers, and monitors.
    3) Reinforce around cut-outs with steel angles or flat bars for the following:
        a) Large panel cutouts; for example, openings for local operator interfaces.
        b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.

3. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
    a. Minimum 16-gauge, Type 304 stainless steel.
    b. Captive stainless steel cover screws threaded into sealed wells.
    c. Inside finish: White polyester powder coating.
    d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.

4. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:
    a. Enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
    b. Door hardware: Stainless steel.
    c. Provide factory installed rain canopy and sun shield for enclosures with operator interface panels.
    d. Bases: Heavy channel, gasketed stainless steel bases, flanges up, for anchoring to pad.

B. Arrangement of components:
    1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
    2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices, or as indicated on the Drawings.
    3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
    4. Control panel mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.

C. Overcurrent protection:
    1. Main overcurrent device:
        a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:
            1) Door-mounted disconnect handles are not acceptable.
            2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
            3) Provide means to defeat the interlock.
            4) Lockable in the off position.
        b. Control panels supplied with 120 VAC:
            1) Provide an internal breaker with the line side terminals covered by a barrier.
            2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
            3) Provide a nameplate prominently positioned on the control panel stating “CAUTION Risk of Electric Shock - UPS equipment outputs remain energized with main disconnect in off position” for any panel containing a UPS.
    2. Provide circuit breakers as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
    3. Selection and ratings of protective devices:
        a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
        b. Voltage rating: Not less than the voltage of the application.

c. Select current rating and trip characteristics to be suitable for:
    1) Maximum normal operating current.
    2) Inrush characteristics.
    3) Coordination of the protective devices to each other and to the source breaker feeding the panel.
d. Circuit breakers, fuses, and motor overcurrent protection devices used for branch circuit protection must be UL 508A compliant.
    1) Circuit breakers listed under UL 1077 Standard for Supplementary Protectors that do not comply with UL 508A requirements are not acceptable.
    2) Miscellaneous, miniature, and micro fuses listed under UL 248 Part 14 that do not comply with UL 508A requirements are not acceptable.
    3) Manual motor controllers provided with an instantaneous-trip overcurrent mechanism listed under UL 508 that do not comply with UL 508A requirements are not acceptable.

4. Provide a separate protective device for each powered electrical device:
    a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
    b. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
        1) Size external fuse to open before any I/O-card-mounted fuses.
    c. Individual discrete inputs shall use a 1/2-amp fuse.
        1) Discrete output:
            a) Size external fuse to open before any I/O-card-mounted fuses.
        2) Analog loop powered from the control panel:
            a) 0.25-amp fuse.
        3) Analog loop powered from the control panel:
            a) 0.25-amp fuse.
    d. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.
5. Fuses for analog and discrete control loops:
    a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
        1) Label shall not cover or interfere with equipment manufacturer’s instructions.
    b. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
    c. Manufacturers: One of the following or equal:
        1) Bussmann.
        2) Ferraz Shawmut.
        3) Littelfuse.
6. Fuse holders:
    a. Modular type:
        1) DIN rail mounting on 35-millimeter rail.
        2) Touch-safe design: Connection terminals to be protected against accidental touch.
        3) Incorporates blown-fuse indicator.
        4) Plug-in style fuse terminals and fuse plugs are not acceptable.
    b. Provide nameplate identifying each fuse:
        1) As specified in Section 26_05_53 - Identification for Electrical Systems.

c. Manufacturers: One of the following or equal:
    1) Allen-Bradley, 1492-FB Series B.
    2) Phoenix Contact, UT4-HESI Series.

7. Control circuit breakers:
    a. DIN rail mounting on 35-millimeter rail.
    b. Manual OPEN-CLOSE toggle switch.
    c. Rated for 250 VAC.
    d. Interrupting rating: 10 kA or available fault current at the line terminal, whichever is higher.
    e. Current ratings: As required for the application.
    f. Provide nameplate identifying each circuit breaker:
        1) As specified in Section 26_05_53 - Identification for Electrical Systems.
    g. Manufacturers: One of the following or equal:
        1) ABB.
        2) Allen-Bradley.
        3) Phoenix Contact, TMC Series.
        4) Square D.
8. Electronic circuit protectors:
    a. Used where a NEC Class 2 power circuit is required.
    b. Confirms to NEC Class 2 according to UL 1310.
    c. DIN rail mounting on 35-millimeter rail.
    d. Power source:
        1) Operating voltage: 24 VDC.
        2) Output current ratings: As required for the application.
        3) Maximum output current: 4 A.
        4) Maximum nameplate rating: 100 VA.
    e. LED for status indication.
    f. Remote status contact.
    g. When using multi-channel electronic circuit protectors, distribute devices such that a failure is limited to a single network or segment.
    h. Provide nameplate identifying each circuit electronic circuit protector module:
        1) As specified in Section 26_05_53 - Identification for Electrical Systems.
    i. Manufacturers: One of the following or equal:
        1) Single channel:
            a) Allen-Bradley, 1694 series.
            b) Phoenix Contact, PTCB E1 series.
        2) Multi-channel:
            a) Phoenix Contact, CBMC series.
            b) Puls PISA11 series.

D. Conductors and cables:
1. Power and control wiring:
    a. Materials: Stranded, soft annealed copper.
    b. Insulation: 600 VAC type MTW.
    c. Minimum sizes:
        1) Primary power distribution: 12 AWG.
        2) Secondary power distribution: 14 AWG.
        3) Control: 16 AWG.

d. Color:
    1) AC power (line and load): Black.
    2) AC power (neutral): White.
    3) AC control: Red.
    4) AC control: Orange for foreign voltages.
    5) DC power and control (ungrounded): Blue.
    6) DC power and control (grounded): White with Blue stripe.
    7) Ground: Green.

2. Signal cables:
    a. Materials: Stranded, soft annealed copper.
    b. Insulation: 600 VAC, PVC outer jacket.
    c. Minimum size: 18 AWG paired triad.
    d. Overall aluminum shield (tape).
    e. Copper drain wire.
    f. Color:
        1) 2-conductor:
            a) Positive (+): Black.
            b) Negative (-): White and red.
        2) 3-conductor:
            a) Positive (+): Black.
            b) Negative (-): Red.
            c) Signal: White.
    g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

E. Conductor identification:
    1. Identify each conductor and cable with unique wire numbers as specified in Section 26_05_53 - Identification for Electrical Systems.
    2. Readily identified without twisting the conductor.

F. General wiring requirements:
    1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
    2. Install components in accordance with the manufacturer’s instructions included in the listing and labeling.
    3. Provide a nameplate on the cover of the control panel identifying sources of power supply and foreign voltages within the control panel.
    4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
    5. Provide power surge protection for control panels.
    6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
    7. Provide non-metallic ducts for routing and organization of conductors and cables:
        a. Provide wiring separation plan.
        b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.

c. Provide separate ducts for signal and low voltage wiring from power and 120 VAC control wiring:
    1) 120 VAC: Grey colored ducts.
    2) 24 VDC: White colored ducts.

8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
    a. Screw-on cable tie mounts.
    b. Hammer-on cable-tie mounting clips.
    c. Fingers of the nonmetallic duct.
9. Wire ties:
    a. No wire ties inside wire duct.
    b. Use Panduit cable tie installation tool, with tension control/cutoff.
    c. Verify cut ends are cut flush filed smooth after installed.
10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
11. Support panel conductors where necessary to keep them in place.
12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
    a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
14. Control panel shall be the source of power for 120 VAC devices interconnected with the control panel, including, but not limited to:
    a. Solenoid valves.
    b. Instruments both mounted in the control panel and remotely connected to the control panel.

G. Provide power circuits for Contractor- and vendor-furnished PLC cabinets in accordance with the PLC and instrument power wiring diagrams indicated on the Drawings or as specified.

H. Thermal management:
1. Provide heating, cooling, and dehumidifying devices in order to maintain instrumentation and control devices to within a range as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation.
2. Air conditioner:
    a. Provide solid-state cabinet coolers or air conditioning units on outdoor panels containing electronic components such as local operator interfaces, panel instruments, programmable logic controllers, or remote I/O.
    b. Provide filters on intake and exhaust openings.
    c. Increase panel sizes as needed to accommodate cooling units.
    d. Closed-loop design.
    e. Power supply: 120 VAC.
    f. Manufacturers: One of the following or equal:
        1) ICEqube, Blade series or IECEx/ATEX for Zones 1 and 2.
        2) Kooltronic, Guardian DP Series.

3. Heating:
    a. Provide panels located in areas that are not climate controlled with thermostatically controlled strip heaters, except where all of the following conditions apply:
        1) Panel is not supplied with 120 VAC power.
        2) There are no electronics or moisture-sensitive devices in the enclosure.
        3) Panel is smaller than 38-inches high.
4. Heat exchanger:
    a. Closed-loop design ensuring separation of ambient air and clean air inside the cabinet.
    b. Filterless design to facilitate easy cleaning of the core.
    c. Mounting: As indicated on the Drawings.
    d. Manufacturers: One of the following or equal:
        1) ICEqube, Blade series.
        2) Noren, CC Series.
5. Enclosure temperature switch:
    a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
    b. Sensor and electronic enclosure.
    c. Accuracy: Within 2 degrees Fahrenheit.
    d. Single contact:
        1) Manufacturers: One of the following or equal:
            a) nVent/Hoffman ATEMNC.
            b) Pfannenberg FLZ.
            c) Rittal.
    e. Dual contact:
        1) Manufacturers: One of the following or equal:
            a) nVent/Hoffman ADLTEMP.
            b) Rittal.
6. Status relays and discrete inputs for switches, power supplies, and fieldbus devices (if applicable):
    a. Provide as indicated on the Drawings or as specified.
7. Fan ventilation:
    a. Provide nVent/Hoffman or Rittal fan speed control:
        1) Provide 2 door/cabinet-mounted vent fans for every 72 inches of cabinet width.
        2) Provide finger-guard kit.
        3) Filter kit with 2 spare filters for each intake fan.
        4) Provide bezel and gasket kit.
        5) [Provide fan shroud.]
        6) Automatically adjust fan speed depending on remote temperature sensor input.
        7) 120 VAC, 60 hertz.
        8) NEMA Type 5-15R cord connections.

I. Panel meters:
1. Pointer type:
    a. Suitable for panel mounting.
    b. Minimum scale length: 3 inches.

c. Calibrated in engineering units.
d. Accuracy: Within 2 percent of span.
e. NEMA Type 4/IP65 sealed front metal bezel.
f. Manufacturers: One of the following or equal:
    1) Red Lion.
    2) Yokogawa.

2. Digital process indicators:
    a. General:
        1) Integral provisions for scaling.
        2) Scale to process engineering units.
        3) Switch-programmable decimal points.
        4) NEMA Type 4/IP65 sealed front bezel.
    b. Current and voltage indicators:
        1) 3-1/2-digit minimum.
        2) Minimum character height: 0.5 inches.
        3) Accuracy:
            a) AC/DC volts: Within 0.1 percent of reading plus 2 digits.
            b) DC current: 4 to 20 mA; within 0.1 percent of reading plus 1 digit.
            c) DC voltage: 0 to 10 volts; within 0.1 percent of reading plus 1 digit.
    c. Operating voltage: 120 VAC.
    d. Operating temperature: 32 degrees to 140 degrees Fahrenheit.
        1) Manufacturers: One of the following or equal:
            a) Action Instruments, Visipak.
            b) Red Lion.

3. Digital bar graph meter:
    a. Self-contained instruments that display process signals directly in engineering units, both in decimal format and as a bar graph display.
    b. Suitable for panel mounting.
    c. LED display:
        1) Not less than 3 decimal digits.
        2) Not less than a 101-segment LED bar graph.
    d. Input signal:
        1) Conventional current loops and voltage control signals.
    e. Minimum sample rate of once per second.
    f. Provisions for field-adjustable scaling and/or offset.
    g. Accuracy shall be within 1 least-significant digit.
    h. Manufacturers: One of the following or equal:
        1) Ametek Dixson.
        2) Weschler Instruments.
        3) Yokogawa.

4. Counters:
    a. 6 digits.
    b. Switch-selectable inputs:
        1) Switch contacts.
        2) CMOS.
        3) TTL.
        4) Magnetic pickup.
        5) RLC sensors.
    c. Selectable up/down control via external signal.
    d. Remote reset.

e. Remote inhibit to prevent accumulating counts.
f. Programmable to enable or disable front panel reset.
g. Non-volatile memory to retain all data upon loss of supply power.
h. Sunlight readable.
i. Operating temperature: 32 degrees to 122 degrees Fahrenheit.
j. Manufacturers: The following or equal:
1) Red Lion, PAX Series.

J. Pilot devices:
1. General:
a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
b. Size:
1) 30.5 millimeters.
c. Heavy duty.
d. Pushbuttons:
1) Contacts rated:
a) NEMA Type A600.
2) Furnish 1 spare normally open contact and normally closed contact with each switch.
3) Equipment shutdown (ESD): Palm or mushroom-head type with self-latching feature. ESD device will remain in the actuated position until deliberately reset.
e. Selector switches:
1) Contacts rated:
a) NEMA Type A600.
b) Knob type.
2) Furnish 1 spare normally open contact and normally closed contact with each switch.
3) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
f. Pilot lights:
1) Type:
a) LED for interior installations.
2) Push to test.
3) Lamp color:
a) On/Running/Start: Red.
b) Off/Stop: Green.
c) Power: White.
d) Alarm: Amber.
e) Status or normal condition: White.
f) Opened: Red.
g) Closed: Green.
h) Failure: Red.
2. Indoor and outdoor areas:
a. NEMA Type 4/13.
b. Manufacturers: One of the following or equal:
1) Allen-Bradley, Type 800T.
2) General Electric, Type CR104P.
3) IDEC, TWND Series.
4) Schneider Electric, Class 9001, Type K.

3. Corrosive areas:
    a. NEMA Type 4X.
    b. Corrosion resistant.
    c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc.
    d. Manufacturers: One of the following or equal:
        1) Allen-Bradley, Type 800H.
        2) Cutler Hammer, Type E34.
        3) IDEC, TWND Series.
        4) Schneider Electric, Class 9001, Type SK.
4. Hazardous (classified) areas/Class I Division 2:
    a. NEMA Type 4X.
    b. Corrosion resistant.
    c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc:
        1) Contacts contained within a hermetically sealed chamber:
            a) Pushbuttons.
            b) Selector switches.
            c) Push-to-test contacts on pilot lights.
        2) UL listed and labeled for Class I Division 2 areas.
    d. Manufacturers: One of the following or equal:
        1) Allen-Bradley, Type 800H.
        2) Cutler Hammer, Type E34.

K. Potentiometer and slidewire transmitters:
1. Provide a DC output in proportion to a potentiometer input.
2. Potentiometer input:
    a. 100 ohms to 100 K ohms.
    b. Impedance greater or equal to 1 M ohms.
    c. Zero turn-up: 80 percent of full-scale input.
    d. Span turn-down: 80 percent of full-scale input.
3. Field-configurable output:
    a. Voltage and current: Conventional current loops and voltage control signals.
4. Accuracy, including linearity and hysteresis, within 0.1 percent maximum at 77 degrees Fahrenheit.
5. Operating temperature: 32 degrees to 131 degrees Fahrenheit.
6. Supply power: 9 to 30 VDC.
7. Manufacturers: One of the following or equal:
    a. Allen-Bradley, Type 800T-U29.
    b. Phoenix Contact, Mini Analog Pro.

L. Signal isolators and converters:
1. Furnish signal isolators that provide complete isolation of input, output, and power input:
    a. Minimum isolation level: 1.0 kilovolts AC/50 hertz for at least 1 minute.
    b. Adjustable span and zero.
    c. Accuracy: Within 1.0 percent of span.
    d. Ambient temperature range: -4 degrees to 149 degrees Fahrenheit.
2. Manufacturers: One of the following or equal:
    a. Acromag, 1500, 600T, 800T, Flat Pack, or ACR Series.

b. Action Instruments, Q500 Series or Ultra SlimPak II.
c. AGM Electronics, Model TA-4000.
d. Moore Industries, MIT 4-Channel.
e. Phoenix Contact, Mini Analog Pro.

M. Relays:
1. General:
a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
c. For plug in type relays, provide a relay base from the same manufacturer as the relay manufacturer.
2. Control:
a. Magnetic style.
b. For use as standard control relay for motor and starter relay logic.
c. NEMA ratings:
1) 300 volts.
2) 10 amps thermal continuous test current.
3) 60 amps make.
4) 6 amps break.
d. Plug-in type.
e. LED indication for energization status.
f. Coil voltages: As required for the application.
g. Minimum poles: DPDT.
h. Touch-safe design: Connection terminals to be protected against accidental touch.
i. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
j. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
k. Relays with screw-type socket terminals.
l. Provide additional relays when the following occurs:
1) Number or type of contacts shown exceeds the contact capacity of the specified relays.
2) Higher contact rating is required in order to interface with starter circuits or other equipment.
m. DIN rail mounting on 35-millimeter rail.
n. Ice-cube-type relays with retainer clips to secure relay in socket.
o. Integrated label holder for device labeling.
p. Manufacturers: One of the following or equal:
1) Allen-Bradley: Type 700 HC.
2) IDEC: R* Series (* = H, J, R, S, U).
3) Potter and Brumfield: Type KRP or KUP.
4) Square D: Type K.
3. Isolation:
a. Electromechanical style.
b. For use as an interposing relay for PLC based discrete I/O signals.
c. NEMA ratings:
1) Switching voltage: 250 volts AC/DC.
2) Limiting current: 6 amps continuous.
3) Interrupt: 1,500 volt-amperes.

d. Plug-in type.
e. LED indication for energization status.
f. Coil voltages: As required for the application.
g. Minimum poles: SPDT.
h. Touch-safe design: Connection terminals to be protected against accidental touch.
i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
j. Relays with screw-type socket terminals.
k. DIN rail mounting on 35-millimeter rail.
l. Integrated label holder for device labeling.
m. Manufacturers: One of the following or equal:
1) Allen-Bradley, Type 700 HL TBR Series.
2) Eaton, XR TBR Series.
3) IDEC, RV8H Series.
4) Phoenix Contact, PLC-INTERFACE Series.

4. Latching:
a. Magnetic-latching control relays.
b. NEMA ratings:
1) 300 volts.
2) 5 amps continuous.
3) 360 volt-amperes make.
4) 320 volt-amperes break.
c. Plug-in type.
d. DIN rail mounting on 35-millimeter rail.
e. Coil voltage: As required for the application.
f. Minimum contacts: DPDT; as required for the application. Plus 1 spare contact.
g. Touch-safe design: Connection terminals to be protected against accidental touch.
h. Clear cover for visual inspection.
i. Provide retainer clip to secure relay in socket.
j. Manufacturers: One of the following or equal:
1) IDEC, RR2KP Series.
2) Square D, 8501, Type K.

5. Time delay:
a. Provide time-delay relays to control contact transition time.
b. Contact rating:
1) 240 volts.
2) 10 amps continuous.
3) 3,600 volt-amperes make.
4) 360 volt-amperes break.
c. Coil voltage: As required for the application.
d. Provide pneumatic or electronic type with on-delay, off-delay, and on/off-delay:
1) For off-delay, use true power-off time-delay relays. Where the required timing range exceeds capability of the off-delay relay use, signal off-delay where power loss will not cause undesirable operation or pneumatic time-delay relays.
e. Minimum contacts: DPDT.

f. Units include adjustable dial with graduated scale covering the time range in each case.
g. Minimum timing range: 0.1 second to 10 minutes, or as required for the application.
h. Manufacturers: One of the following or equal:
1) Allen-Bradley, Type 700-HR.
2) IDEC, RTE Series.
3) Tyco Electronics, Agastat 7000 Series (pneumatic).

N. Terminal blocks:
1. DIN rail mounting on 35-millimeter rail.
2. Rated for 15 amps at 600 volts.
3. Screw terminal type.
4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
5. Finger-safe protection for terminals for conductors.
6. Construction: Polyamide insulation material capable of withstanding temperature extremes from -40 degrees to 221 degrees Fahrenheit.
7. Terminals: Plainly identified to correspond with markings on the diagrams:
a. Permanent machine-printed terminal identification.
8. Disconnect-type field signal conductor terminals with socket/screw for testing.
9. Identify terminals suitable for use with more than 1 conductor.
10. Position:
a. So that the internal and external wiring does not cross.
b. To provide unobstructed access to the terminals and their conductors.
11. Manufacturers: One of the following or equal:
a. Allen-Bradley, 1492 Series.
b. Phoenix Contact, UT4 Series.

O. DIN rail grounding:
1. Grounding terminal blocks used exclusively for bonding each DIN rail section to panel grounding busbar shall:
a. Mount to DIN rail via grounding foot with mounting screw.
b. Connect to the panel grounding busbar shall be via a green insulated conductor sized in accordance with NEC.
c. Not be used for grounding signal cable shields.
2. Screw terminal type.
3. DIN rail mounting on 35-millimeter rail.
4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
5. Finger-safe protection for terminals for conductors.
6. Terminals: Plainly identified to correspond with markings on the diagrams:
a. Permanent machine-printed terminal identification.
7. Manufacturers: One of the following or equal:
a. Allen-Bradley, 1492-JG Series.
b. Phoenix Contact, USKLG Series.

P. Wire duct:
1. Provide flame retardant plastic wiring duct, slotted with dust cover.

2. Type:
    a. Wide slot.
    b. Narrow slot.
    c. Round hole.
3. Manufacturers: One of the following or equal:
    a. ABB.
    b. Iboco.
    c. Panduit.
    d. Phoenix Contact.

Q. DIN rail:
1. Perforated steel.
2. 35-mm width.
3. 15-mm deep.
4. Provide 2-inch offset using one of the following:
    a. Offset brackets.
    b. Preformed standoff DIN Rail Channel.

R. Surge protection devices (SPD):
1. 120 VAC control panel power SPD:
    a. Provide SPD for panel 120 VAC power entrances:
        1) Non-faulting and non-interrupting design.
        2) Provide line to neutral and neutral to ground surge protection.
    b. Provide surge protection at secondary of main circuit breaker:
        1) Surge protection is not required for 120 VAC circuits that are only used for panel lights and receptacles.
        2) For panels receiving power at 480 VAC, provide surge protection on the 120 VAC control power transformer secondary.
    c. DIN rail mounting.
    d. Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
        1) Gastight connections.
        2) Visual status indication of MOV status on the input and output circuits.
        3) Dry contact rated for remote status indication.
    e. Approvals:
        1) Tested in accordance with IEC 61643-11.
        2) Tested in accordance with UL 1283.
        3) Tested in accordance with UL 1449.
        4) Surge protection minimum requirements: Withstand a minimum 10-kA test current of an 8/20 µs waveform in accordance with IEEE C62.41.1 Category C Area.
    f. Manufacturers: One of the following or equal:
        1) ASCO, Model 277.
        2) Phoenix Contact, Type SFP Filter.
        3) Rockwell, 4983-DC series.
        4) Sola HD, STFE Elite series.
2. 24 VDC control panel power SPD:
    a. Provide SPD for 24 VDC power circuits.
    b. Provide surge protection at DC power supply output.
    c. DIN rail mounting.

d. Attach wiring to the SPD by means of a screw-type cable clamping terminal block:
    1) Optical status indicator.
    2) Dry contact rated for remote status indication.
e. Approvals:
    1) Tested in accordance with IEC 61643-11.
f. Manufacturers: One of the following or equal:
    1) Field instruments that require auxiliary power:
        a) Emerson, Model 265 (SLAC) series.
        b) Phoenix Contact, Plugtrab PLT--SEC-T3-24-FM-UT.
    2) Loop powered field instruments:
        a) Emerson/Edco, Model SS65-036-2.

3. Panel mounted control, signal, and data line SPD:
    a. General:
        1) This section applies to SPD located in a control panel, field panel, network junction box, or marshalling panel.
        2) Approvals:
            a) Tested in accordance with IEC 61643-21.
            b) Tested in accordance with UL 497B.
        3) SPD shall consist of 2 parts:
            a) Base module:
                (1) DIN rail mounting.
                    (a) Grounded to DIN rail via mounting rail foot.
            b) Plug protection module:
                (1) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
        4) Provide indirect shield ground style SPD unless otherwise noted.
        5) Provide ability to locally identify and indicate SPD health.
        6) SPD shall be provided with controller module with dry contact for remote status monitoring of SPD device health.
        7) SPD modules shall be compatible with signal, communication bus type, data type, or control power being protected.
        8) Provide dedicated SPD for each signal, communication bus type, or data line being protected.
    b. Manufacturers: One of the following or equal:
        1) Dehn, Blitzductor XTU Series.
        2) Phoenix Contact, Plugtrab PT-IQ Series.
4. Copper Ethernet SPD:
    a. Protects network equipment from lightning or other surge events.
    b. Suitable for Gigabit networks.
    c. Shielded RJ-45 ports.
    d. Compliant with PoE standards IEEE 802.3af and 802.3at.
    e. Nominal discharge surge current: 10 kA.
    f. Approvals:
        1) Tested in accordance with IEC 61643-21.
        2) Tested in accordance with UL 497B.
    g. Manufacturers: One of the following or equal:
        1) Citel, MJ8-C6A.
        2) Eaton/MTL, ZoneBarrier High Energy Ethernet.
        3) Phoenix Contact, DT-LAN-CAT6+.
        4) Weidmuller, VDATA CAT6.

5. Field device mounted SPD:
    a. Conduit entry mounting.
        1) Provide parallel or through wiring configurations as required by the application.
            a) Use parallel wiring configuration if there is an available cable gland at the device.
            b) Use through wiring configuration if there is no available cable gland at the device.
        2) Provide screw connections compatible with field device.
    b. NEMA 4X stainless steel material housing.
    c. Approvals:
        1) Tested in accordance with IEC 61643-21.
    d. 4-wire field device:
        1) Module shall provide simultaneous protection of signal cable, communication bus, or data line, and power supply line.
            a) Maximum continuous voltage:
                (1) DC:
                    (a) Signal: 32 VDC.
                    (b) Power supply: 255 VDC.
                (2) AC:
                    (a) Signal: 22.6 VAC.
                    (b) Power supply: 255 VAC.
        2) Manufacturers: The following; Engineer knows of no equal:
            a) Endress+Hauser, HAW569-CB2C.
    e. 2-wire or 3-wire field device:
        1) Module shall provide protection for the signal cable, communication bus or data line.
        2) Manufacturers: One of the following or equal:
            a) Eaton/MTL, TP Series.
            b) Endress+Hauser, HAW569 Series.
            c) Phoenix Contact, Surgetrab S-PT Series.

S. Horns and beacons:
    1. Beacons/horn combination units:
        a. Manufacturers: One of the following or equal:
            1) Edwards, Multi-Status LED 108i with tone module.
            2) Federal Signals, AV1ST Strobe Combination Audible/Visual Signal.
        b. LED Colors: Red, Green, and Amber.
        c. Power: 120 VAC.
        d. Provide accessories such as pipe mount flange, pipe extensions, corner mount brackets, or wall mount brackets as needed.
        e. Horn rated 80 dB minimum at 10 feet.
    2. Dedicated beacon unit:
        a. Manufacturers: One of the following or equal:
            1) Allen-Bradley, 855 B *-* 10 Series.
            2) Edwards, 102 Series.
            3) Federal Signal Corp., Starfire Series.

3. Dedicated horn unit:
    a. Electromechanical:
        1) Manufacturers: One of the following or equal:
            a) Edwards, 878EX or 879EX Series.
            b) Federal Signal, 350 or 31X Series.
    b. Electronic:
        1) Manufacturers: One of the following or equal:
            a) Allen-Bradley, 855H or 855XH Series.
            b) Edwards, 5530M or 5533MD Series.
            c) Federal Signal, 300GCX or 300X Series.
    c. Rated for 80 dB minimum at 10 feet.

T. Power supplies:
1. Configure power supply system so that either the primary or backup supply can be removed, repaired or replaced, and returned to service without disrupting the system operation.
2. Convert 120 VAC to 24-volt DC or other DC voltages required or as required for the application.
3. Provide redundant backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure in either a 1+1 or N+1 configuration as required:
    a. Provide automatic switchover upon module failure.
    b. Alarm contacts monitored by the PLC.
5. Provide protective isolation between power supply units either by means of Diodes, Diode Modules, MOSFET Modules, or use power supplies with built in redundancy. Power supplies with built in redundancy must actively isolate each power supply and be designed as such.
6. Sized to provide 40-percent excess rated capacity.
7. UL 508 listed to allow full-rated output without de-rating.
8. Provide fuse or short-circuit protection.
9. Provide a minimum of 1 set of dry contacts for each power supply configured to change state on failure for monitoring and signaling purposes.
10. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change.
11. Operating temperature range: 32 degrees to 140 degrees Fahrenheit.
12. Touch-safe design: Connection terminals to be protected against accidental touch.
13. DIN rail mounting on 35-millimeter rail:
    a. Mount the power supply in the proper orientation as recommended by the manufacturer to ensure adequate thermal dispersion without derating the power supply.
14. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
15. Manufacturers: One of the following or equal:
    a. Fully redundant:
        1) IDEC, PS5R Series:
        2) Phoenix Contact, Quint Power Supply with SFB technology.
            a) Phoenix Contact, Quint.

3) PULS.
4) Sola.

b. Redundancy module:
1) Phoenix Contact, O-ring redundancy module.

U. Intrinsic safety barriers:
1. Transformer isolated barrier:
a. Containing a transformer to provide complete:
1) Isolation between the safe and hazardous areas for loop-powered devices.
2) 3-way isolation between the safe area, hazardous area, and power supply powered devices.
b. Resistor for current limitation.
c. Fuses for short-circuit protection.
d. Provide barriers with pluggable connectors that are coded for easy replacement.
e. Transmission error shall be less than or equal to 0.1 percent of full-scale.
f. DIN rail mounting on 35-millimeter rail.
g. Approvals:
1) FM.
2) UL 913.
2. Types:
a. Switch isolators:
1) Designed and approved for use with discrete inputs.
2) Supply power: 20 to 30 VDC.
3) Output to track input.
4) LED in the cover to indicate the status of the input.
5) Selector switch to change the logic of the input.
6) Input: Dry contact.
7) Output: SPDT relay.
b. Transmitter and converters for use with 4- to 20-mA signals without Hart® communications capability:
1) Designed and approved for use with 4- to 20-mA analog signals.
2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
3) Supply voltage: 20 to 30 VDC.
c. Transmitter and converters for use with 4- to 20-mA signals with Hart® communications capability:
1) Designed and approved for use with 4- to 20-mA analog signals.
2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
3) Transfer digital signals from the hazardous area to the safe area.
4) Complete bi-directional communication between a smart transmitter located in the field and the suitable equipment located in the safe area.
5) Supply voltage: 20 to 30 VDC.
3. Manufacturers: One of the following or equal:
a. Pepperl + Fuchs.
b. Phoenix Contact, MACX Series.

V. Limit switches:
   1. NEMA Type 4X.
   2. AC contact rating 120 volts, 10 A.
   3. DC contact rating 125 volts, 0.4 A.
   4. Provide robust actuation mechanism not prone to degradation.
   5. Provide complete actuator mechanism with required hardware.
   6. Allows for contact opening even during contact weld condition.
   7. UL approved.
   8. Operating temperature range: 0 degrees to 230 degrees Fahrenheit).
   9. Manufacturers: One of the following or equal:
      a. ABB.
      b. Allen-Bradley, 802 Series.
      c. Eaton, E47, E49, E50.
      d. Honeywell, HDLS Series.
      e. Omron, D4 Series.

W. Proximity switches:
   1. Power supply: 24 VDC supply voltage.
   2. 1 normally open and normally closed contacts.
   3. LED optical sensing, polar-retro.
   4. Distance: 6 meters (19.8 feet).
   5. Manufacturers: The following or equal:
      a. Banner T30 or equal.

X. Current switches:
   1. Power supply: 120 VAC supply voltage.
   2. 1 normally open and normally closed contacts.
   3. Adjustable current setting.
   4. Manufacturers: One of the following or equal:
      a. Phoenix Contact, EMD Series.
      b. Zelio®, RM35.

Y. Current switches:
   1. Input current range: As indicated on the Drawings.
   2. Output: Normally-open contact closure rated 1A at 120VAC.
   3. Power supply: 24 VDC supply voltage.
   4. Output overload protected.
   5. Accuracy: Within 0.5 percent full-scale.
   6. Ripple and Noise: 1 percent max., peak to peak.
   7. Frequency: 50/60 hertz.
   8. Manufacturers:
      a. American Aerospace: 1070 Series.
      b. CR Magnetics: CR4320 series.
      c. Phoenix Contact: Mini Analog Pro Series.

2.06 ACCESSORIES

A. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings, including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.

B. Provide floor stands or legs with a minimum height of 12 inches where needed or as indicated on the Drawings.

C. Provide a folding shelf for enclosures that contain programmable controllers. Shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.

D. Provide nameplate to each panel as indicated on the Drawings:
   1. As specified in Section 26_05_53 - Identification for Electrical Systems on internal and external instruments and devices.
   2. With the following markings that is plainly visible after installation:
      a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
      b. Supply voltage, phase, frequency, and full-load current.
      c. Power source or circuit ID.
      d. Short-circuit current rating of the panel based on one of the following:
         1) A listed and labeled assembly.
         2) Established utilizing an approved method.

E. Provide a window kit where indicated on the Drawings or where a transmitter with display is mounted inside a control panel. Window shall meet the following requirements:
   1. Safety plate glass.
   2. Secured by rubber locking seal.
   3. Allow full viewing of devices issuing visual process data or diagnostics.

F. Lighting:
   1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
      a. Covered or guarded.
      b. Provide On-Off door-activated switches where indicated on the Drawings.
      c. 120-volt, single-phase, 15-amp style plug.
      d. Provide 4,000 K, 900 lumens LED fixture.
         1) Provide additional fixtures for every 36 inches of width.

G. Receptacles:
   1. Provide 1 duplex receptacle located every 6 feet of enclosure width, spaced evenly along the back mounting panels.
   2. GFCI, 120-volt, single-phase, 15-amp style plug.
   3. Provide circuit breaker or fuse to limit receptacle draw to 5 amps.

H. Grounding:
   1. Provide the following:
      a. Grounding strap between enclosure doors and the enclosure.
      b. Equipment grounding conductor terminals.
      c. Provide equipment grounding busbar with lugs for connection of equipment grounding wires.
      d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding busbar.
   2. Identify equipment grounding conductor terminals with the word "GROUND," the letters "GND", the letter "G", or the color green.

3. Signal cable shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
8. Unless otherwise noted, connect exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.
9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.
    a. Control panel ground lugs and ground bar shall be copper mechanical or compression connection type. Aluminum connectors or lugs are not acceptable for use with copper conductors.

I. Sunshades:
1. Where indicated, provide panel-mounted sunshades for outdoor installations.
2. Provide thermally insulated standoff.
3. Provide deburred cutouts for access to exterior panel accessories.
4. Material of sunshade and mounting hardware shall match enclosure.

2.07 FINISHES

A. Finishes:
1. Metallic (non-stainless):
    a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.
    b. Scratches or blemishes shall be filled before finishing. 1 coat of zinc phosphate shall be applied according to the manufacturer's recommended dry-film thickness and allowed to dry before applying the finish coat.
    c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
    d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.
2. Stainless steel:
    a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

B. Colors:
1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
3. Panel interiors shall be manufacturer's standard white.

PART 3 EXECUTION

3.01 PREPARATION

A. Equipment support and anchoring to structures:
   1. As specified in Section 01_81_50 - Design Criteria, including, but not limited to:
      a. Anchor bolt layout.
      b. Equipment templates.
      c. Anchor installation.

3.02 INSTALLATION

A. Install enclosures so that their surfaces are plumb and level within 1/8-inch over the entire surface of the panel: Anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details.

C. Provide floor stand kits for wall-mounted enclosures larger than 48-inches high.

D. Provide concrete housekeeping pads for freestanding enclosures.
   1. Refer to the structural typical details.

E. Install gasket and sealing material under panels with floor slab cutouts for conduit:
   1. Undercoat floor-mounted panels.

F. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.

G. Holes for field conduits, etc., shall be cut in the field. No additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miscut holes shall require that the entire enclosure be replaced.

H. Protect wiring from sharp edges and corners.

I. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the Conduit Schedule but shall be shown on the loop drawings prepared by the Contractor.

J. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.

K. Side panels:
   1. Side panels shall be kept free of control equipment and devices. Any deviation must be sent to the Engineer in writing asking for a deviation.

3.03 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning.

END OF SECTION

SECTION 40_67_26

CONTROL SYSTEMS: UNINTERRUPTIBLE POWER SUPPLIES 10 KVA AND BELOW

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Single-phase double conversion uninterruptible power supplies rated 10 kVA and below.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. Federal Communications Commission (FCC):
      a. FCC Part 15:
         1) Class A.
         2) Class B.
      b. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   3. Underwriters Laboratories, Inc. (UL):
      a. UL 1778 - Standard for Uninterruptible Power Supply Systems and Equipment.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Critical load: Load supplied by the UPS.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. Manufacturer and model number.
   2. Catalog data.
   3. Dimensions:
      a. Height.
      b. Width.

c. Depth.
d. Weight.

4. Ratings:
   a. Input voltage.
   b. Output voltage.
   c. Input/output power factor.
   d. Efficiency.
   e. Harmonic distortion.
   f. Runtime.
5. Noise specifications.
6. Heat dissipation.
7. Warranties and maintenance contracts:
   a. Descriptive package of offerings of preventative and full-service maintenance contracts for both UPS system and batteries.
8. Communications requirements such as software, cards, etc.
9. Alarms and status available for remote monitoring and system health.

C. Shop Drawings:
   1. Power distribution block diagrams.
   2. Front and rear views of equipment enclosures:
      a. Front elevation, including control and indicating devices.
   3. Support points and weight of overall equipment.
   4. Schematic and control wiring diagrams, including, but not limited to:
      a. Line and load terminals.
      b. Alarm and status terminals.
      c. Manual maintenance bypass switch terminals.
      d. External battery or step-down/step-up transformers, if any.
      e. External wiring requirements for communication signals.
   5. Switching and overcurrent protective devices.

D. Calculations:
   1. Include derating for temperature and elevation as necessary.
   2. UPS sizing computation:
      a. Apply safety factors as specified in this Section.
      b. Provide itemized list of critical loads, including individual VA and watt ratings.
   3. Battery time calculation based on specified runtime for total load with the safety factor multiplied to it. Table/graph for back-up time calculation.
   4. Load calculation shall include power for all shown in the power distribution drawing, which includes, but is not limited to, PLC power supply, field instruments (120 VAC and 24 VDC), instrument power, Ethernet switches, and I/O modules. Refer to network drawings for additional information and notes.
   5. Total battery recharge time as a function of capacity utilized.

E. Design data:
   1. Design mounting and anchorage for seismic design criteria specified in Section 01_81_50 - Design Criteria:
      a. Provide seismic kits as required to meet design criteria.

F. Record documents:
   1. Provide record drawings of installed unit(s), including layout and wiring.

G. Manufacturer's field reports.

H. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
   2. System instruction manuals that describe troubleshooting, installation, operations, and safety procedures.
   3. Recommendations for maintenance procedures and intervals.
   4. Battery data/replacement information.
   5. Parts list.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications:
   1. A minimum of 10 years' experience in the design, manufacture, and testing of solid-state UPS systems.
   2. ISO 9001 certified.

B. Regulatory requirements for complete UPS system:
   1. UL listed in accordance with UL 1778.
   2. IEEE C62.41, Category B.
   3. FCC 15:
      a. Greater than 2,000 VA - Class A.
      b. Less than 2,000 VA - Class B.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide complete, factory-assembled, wired, and tested, true on-line double conversion UPS equipment, including, but not limited to, rectifier, DC bus, inverter, battery charger, batteries, automatic bypass, and ancillary components as specified in this Section and as indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Critical loads as indicated on the Drawings.

2.03 MANUFACTURERS

A. Double conversion true online UPS system:
   1. One of the following or equal:
      a. Eaton, 9PX Series.
      b. Vertiv, Liebert GXT5 Series.

2.04 MANUFACTURED UNITS

A. Design requirements:
   1. Minimum VA rating of the UPS shall be greater than or equal to the safety factor (as indicated in the UPS schedule) times the connected load or 700 VA, whichever is greater.
   2. UPS system input:
      a. Voltage:
         1) Less than or equal to 3 kVA UPS:
            a) 120 VAC within 3 percent, single-phase, 2-wire plus ground (L1, N, G).
         2) Greater than 3 kVA UPS:
            a) 208 VAC within 5 percent, single-phase, 3-wire plus ground (L1, L2, N, G).
         3) Frequency: 60 hertz:
            a) Auto sensing on initial power up.
            b) User configurable.
      b. Current harmonic distortion (THDi%):
         1) Less than or equal to 5 percent at full load operation.
      c. Power factor:
         1) Greater than or equal to 0.99 lagging at rated load.
      d. Connections:
         1) As specified and as indicated on the Drawings.
   3. UPS inverter:
      a. Output voltage:
         1) Less than or equal to 3 kVA UPS:
            a) Standard:
               (1) 120 VAC.
            b) User selectable:
               (1) 100 VAC, 110 VAC, 120 VAC, 125 VAC.
         2) Greater than 3 kVA UPS:
            a) Standard:
               (1) 208 VAC.
            b) User selectable: A.
               (1) 200 VAC, 208 VAC, 220 VAC, 230 VAC, 240 VAC.
      b. AC-AC efficiency:
         1) Greater than or equal to 89 percent at full rated resistive linear load.
      c. Transient recovery time:
         1) To nominal voltage within 100 milliseconds.
      d. Voltage regulation:
         1) Within 1 percent steady state.
      e. Output voltage distortion (THDV%):
         1) Linear load: Less than 2 percent.
         2) Non-linear load: Less than 5 percent.

f. Output power factor:
1) Load power factor range shall be 0.65 lagging to 1.0 (unity) leading without power derating.
g. Current overload capability:
1) UPS shall attempt to clear overloads while maintaining normal operation before transferring to bypass.
2) Bypass transfer thresholds shall follow inverse time-current characteristic that operates when the load exceeds the nameplate rating of the UPS.
3) Transfer load to bypass when overload capacity is exceeded.

4. Batteries:
a. Internal battery shall utilize lithium-ion cells.
b. UPS shall have capability for connection of external battery modules to extend total available run time. External batteries shall match the UPS in aesthetics and color.

5. Mounting:
a. Configurable for rack and tower mounting applications.
b. Provide manufacturer's standard mounting kit as required by the application.

6. Cooling:
a. UPS shall have integral forced air cooling.

7. Output connections:
a. Receptacles:
1) Less than or equal to 3 kVA UPS:
a) Provide a minimum of four NEMA Type 5-15R or Type 5-20R receptacles.
b) Provide at least one NEMA Type L5-30R receptacle.
2) Greater than 3 kVA UPS:
a) Provide a minimum of four NEMA Type 5-20R receptacles.
b) Provide at least one NEMA Type L14-30R receptacle.
3) Provide hardwired connections as required and as indicated on the Drawings.

B. Environmental requirements:
1. Operating ambient temperature:
a. UPS module: 50 degrees Fahrenheit to 104 degrees Fahrenheit (10 degrees Celsius to 40 degrees Celsius).
b. Battery: 68 degrees Fahrenheit to 86 degrees Fahrenheit (20 degrees Celsius to 30 degrees Celsius).

2. Operating altitude:
a. Project Site conditions as specified in Section 01_81_50 - Design Criteria.

3. Surge protection:
a. UPS shall be accordance with IEEE C62.41, Category B.

4. Audible noise:
a. Less than 46 dB at 1 meter.

C. Communications:
1. Relay outputs:
a. Provide low voltage signals for On Battery, Low Battery, Any Mode Shutdown, and Battery Mode Shutdown.
b. Connections on a terminal block on the rear panel.

2. Serial:
    a. RS-232 serial connection.
3. USB:
    a. Provide a USB connection that is HID compliant for network connection.

2.05 ACCESSORIES

A. External maintenance bypass:
    1. Manufacturers: One of the following or equal:
        a. Eaton, HotSwap MBP Series.
        b. Vertiv, Liebert Micropod Series.
    2. Properties:
        a. Provides isolation of the UPS for maintenance purposes.
        b. Provide maintenance bypass from the same manufacturer as the UPS manufacturer.
        c. UL 1778 listed.
        d. Provide manufacturer's recommended mounting kit as required by the application.
        e. Make-before-break design so that UPS can be isolated from the critical loads by placing these loads on source power without interruption of operation.
        f. Utility and UPS status indications.
        g. Rated to carry the full input current of the UPS.
        h. Connections to match UPS connections and as indicated on the Drawings.
        i. Supply necessary input/output cords and receptacles for connections with power source and UPS.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with the manufacturer's instructions.

B. Do not utilize extension cords, adapters, or other electrical connectors for UPS input.

3.02 FIELD QUALITY CONTROL

A. Perform inspections and test procedures before UPS startup:
    1. Inspect equipment for signs of damage.
    2. Verify installation as indicated on the Drawings and specified in the Specifications.
    3. Inspect cabinets for foreign objects.
    4. Verify neutral and ground conductors are properly sized and terminated.
    5. Inspect battery cases.
    6. Inspect batteries for proper polarity.
    7. Check power and control wiring for tightness.
    8. Check terminal connectors for tightness.
    9. Ensure connection and voltage of the battery string(s).

END OF SECTION

SECTION 40_71_15

FLOW MEASUREMENT: MAGNETIC FLOWMETERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Full-body magnetic flowmeters.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. International Organization for Standardization (ISO):
      a. 9000 - Quality management systems - Fundamentals and vocabulary.
      b. 17025 - General requirements for the competence of testing and calibration laboratories.
   2. National Institute of Standards and Technology (NIST).
   3. NSF International (NSF).

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Include sizing information from the manufacturer that includes:
   1. Chart of the measurement error from zero to maximum measured volumetric flow range indicated in datasheets.
   2. Indication of input parameters and their values used in the calculations.

C. Quality Control Submittals:
   1. Manufacturer's representative qualifications as specified in Section 01_75_17 - Commissioning.

D. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.

2. Physical conditions:
    a. Installation and mounting requirements.
    b. Location within the process.
    c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Manufacture instrument facilities certified to the quality standards of ISO 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
    1. ABB, Watermaster.
    2. Emerson, Rosemount 8750W.
    3. Endress+Hauser:
        a. Proline Promag H Series 300/500.
        b. Proline Promag W Series 300/500.
    4. Krohne, IFC.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Flow Measurement: Magnetic Flowmeters.

B. Magnetic flowmeter:
   1. General:
      a. Magnetic flowmeters obtain the flow velocity by measuring the changes of induced voltage of the conductive fluid passing across a controlled magnetic field.
      b. Complete zero stability shall be an inherent characteristic of the flowmeter system.
      c. Include for each magnetic flow metering system:
         1) A metering tube with electrodes (sensor).
         2) Fully welded flanges that are rated for the full pressure class of the piping.
         3) Signal cable if remote mounted.
         4) Transmitter integral or remote as indicated on the Drawings.
         5) Flowmeter grounding rings.
   2. Performance requirements:
      a. Accuracy:
         1) 0.25 percent of flow rate from 10 to 100 percent of full-scale for velocities ranging between 1.9 to 10 feet per second.
      b. Repeatability:
         1) 0.25 percent of rate.
   3. Element:
      a. Metering tube:
         1) Constructed of Type 304 or 316 stainless steel (unless specifically noted otherwise in the instrument datasheet) with flanged connections to match with piping material.
            a) Carbon steel cannot be used when coils are on the outside of the metering tube, it will not pass the magnetic field.
            b) Coils that are embedded in the liner are not permitted.
         2) Liner material in conformance with:
            a) Manufacturer’s recommendations for the intended service.
            b) NSF certified for drinking water applications.
         3) Electrodes type and material in conformance with:
            a) Manufacturer’s recommendations for the intended service.
            b) Utilize a minimum of 2 self-cleaning electrodes.
         4) As indicated in the datasheets.
         5) Meter terminal housing NEMA Type 4X, unless installed in locations such as vaults that will experience submergence. In those applications NEMA 6P is required.
         6) Meter coating consisting of epoxy painted finish.
         7) Components:
            a) 2 grounding rings:
               (1) Which are in conformance with the manufacturer’s bore and material recommendation for the meter’s intended service.
   4. Transmitter:
      a. Power supply:
         1) As indicated in the datasheets.

b. Outputs:
    1) As indicated in the instrument datasheet.
    2) For instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.
c. Microprocessor-based signal converter/transmitter.
d. Utilize DC pulse technique to drive flux-producing coils.
e. Contain a 6-digit display for flow rate, percent of span, and totalizer.
f. Operator keypad interface.
g. Integral zero return to provide consistent zero output signals in response to an external dry contact closure.
h. Integral low flow cut-off zero return.
i. Programmable parameters, including:
    1) Meter size.
    2) Full-scale flow rate.
    3) Magnetic field frequency.
    4) Time constant.
j. Data retention for a minimum of 5 years without auxiliary main or battery power.
k. Self-diagnostics and automatic data checking.
l. Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
m. Ambient operating temperature limits of -5 to 140 degrees Fahrenheit (-20 to 60 degrees Celsius).
n. Enclosure:
    1) As indicated in the instrument datasheet.

2.05 ACCESSORIES

A. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

B. Provide sunshades for transmitters located outdoors.

C. Provide galvanic isolation gaskets, nylon/Teflon™ flange bolt insulation bushings, and nylon washers on meters installed on pipes with cathodic protection.

2.06 SOURCE QUALITY CONTROL

A. Factory calibrate each flow metering system at a facility that is traceable to the NIST.
    1. ISO 17025 accredited test facility with certified accuracy traceable to NIST.
    2. Suggestion, the calibration facility be traceable to international standards and ILAC, International Laboratory Accreditation Committee MRA, Mutual Recognition Agreement.
    3. This ensures worldwide accreditation of calibration laboratories.

B. Evidence of accreditation shall originate from a national verification agency such as A2LA ILAC.

C. FM approval certification or equal when installed in classified areas.

D. A real-time computer-generated printout of the actual calibration date indication actual velocities and as read values of the flow tube.
   1. Flow calibration report of the manufacturers flow lab calibration procedure shall be shipped with the meter system.
   2. Minimum calibration shall be a 3 point calibration, including 1, 3, and 10 feet per second velocities for every meter and transmitter system. 2 points at 15 to 20 percent and 80 to 100 percent are statistically proven to be sufficient calibration points.
   3. Manufacturer shall archive calibration reports for future reference.

PART 3 EXECUTION

3.01 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. For instruments located outdoors or where instrument elements and transmitters are separated by conduit located outside the building envelope, provide surge protection devices at the transmitters.

3.02 CALIBRATION AND TESTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

B. Calibration verification:
   1. Verify factory calibration of instruments in accordance with the manufacturer's instructions.
      a. Verify flow meter performance to the original manufacturer specifications.
   2. Verification shall be traceable to factory calibration using a third party, attested onboard system pursuant to ISO standards.
   3. Verification report in accordance with common quality systems such as ISO 9000 to prove the reliability of the meter-specified accuracy.
   4. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.03 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

3.04 SCHEDULES

A. Instrument datasheets included in this Section.

B. The provided information does not necessarily include all required instruments.

C. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - FLOW MEASUREMENT: MAGNETIC FLOWMETERS

Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	FIT-42003 (FE-42003)	**MEASURING PRINCIPLE**	MAGNETIC
SPECIFICATION NUMBER	40_71_15	**PLC**	PLC-420
DRAWING NUMBER	420N101	**POWER LOCATION**	LCP-42020
SERVICE	MAGNETIC FLOW METER	**TYPICAL DETAIL(S)**	NF130, NF135

CONNECTION

LINE SIZE	6"	**PROCESS CONNECTION**	ANSI 150
LINE MATERIAL	GLDIP	**PROCESS CONN. MATERIAL**	GLDIP

FLUID

FLUID	BLENDED SLUDGE	**PRESSURE**	175 PSIG
NOMINAL FLOW	60 GPM	**TEMPERATURE**	70 DEG F
FLOW RANGE	0-500 GPM	**VISCOSITY**	N/A
		CONDUCTIVITY	N/A

ELEMENT

ELEMENT TAG NO.	FE-42003	**PROCESS CONNECTION**	ANSI 150
ENCLOSURE CLASS	NEMA 4X	**LINER MATERIAL**	PTFE
HAZARDOUS APPROVALS	N/A	**VACUUM POSSIBILITY**	NO
TUBE SIZE	6"	**ELECTRODE TYPE**	MFR. STD.
TUBE MATERIAL	MFR. STD.	**ELECTRODE MATERIAL**	316 SST

TRANSMITTER

TRANSMITTER TAG NO.	FIT-42003	**HAZARDOUS APPROVALS**	N/A
MOUNTING	REMOTE	**EMPTY PIPE DETECTION**	YES
ENCLOSURE CLASS	NEMA 4X	**BI DIRECTIONAL FLOW**	NO
POWER	120VAC-1P	**PULSE OUTPUT**	NO
AMBIENT TEMPERATURE	70 DEG F	**RELAY OPTIONS**	YES
OUTPUT	4-20 MA	**POTTED ELECTRONICS**	NO
SURGE PROTECTION	NO	**CATHODIC PROT. LINE**	NO

NOTES

[*]

Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	FIT-53013 (FE-53013)	**MEASURING PRINCIPLE**	MAGNETIC
SPECIFICATION NUMBER	40_71_15	**PLC**	RIO-53A
DRAWING NUMBER	530N104	**POWER LOCATION**	PCM
SERVICE	MAGNETIC FLOW METER	**TYPICAL DETAIL(S)**	NF130, NF136

CONNECTION

LINE SIZE	4"	**PROCESS CONNECTION**	ANSI 150
LINE MATERIAL	GLDIP	**PROCESS CONN. MATERIAL**	GLDIP

FLUID

FLUID	THICKENED SLUDGE	**PRESSURE**	175 PSIG
NOMINAL FLOW	60 GPM	**TEMPERATURE**	70 DEG F
FLOW RANGE	0-500 GPM	**VISCOSITY**	N/A
		CONDUCTIVITY	N/A

ELEMENT

ELEMENT TAG NO.	FE-53013	**PROCESS CONNECTION**	ANSI 150
ENCLOSURE CLASS	NEMA 4X	**LINER MATERIAL**	HARD RUBBER
HAZARDOUS APPROVALS	N/A	**VACUUM POSSIBILITY**	NO
TUBE SIZE	4"	**ELECTRODE TYPE**	MFR. STD.
TUBE MATERIAL	MFR. STD.	**ELECTRODE MATERIAL**	316 SST

TRANSMITTER

TRANSMITTER TAG NO.	FIT-53013	**HAZARDOUS APPROVALS**	N/A
MOUNTING	INTEGRAL	**EMPTY PIPE DETECTION**	YES
ENCLOSURE CLASS	NEMA 4X	**BI DIRECTIONAL FLOW**	NO
POWER	120VAC-1P	**PULSE OUTPUT**	NO
AMBIENT TEMPERATURE	70 DEG F	**RELAY OPTIONS**	YES
OUTPUT	4-20 MA	**POTTED ELECTRONICS**	NO
SURGE PROTECTION	NO	**CATHODIC PROT. LINE**	NO

NOTES

[*]

SECTION 40_71_43

FLOW MEASUREMENT: ROTAMETERS (VARIABLE AREA FLOWMETERS)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Rotameters (variable area flowmeters).

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Brooks.
   3. King Instrument Co.

2.04 MANUFACTURED UNITS

A. Rotameters:
   1. General:
      a. Variable area type flowmeters with local flow indication.
      b. Material construction:
         1) As indicated in the datasheet.
      c. Metal tube type:
         1) For applications above 100 pounds per square inch gauge, with hazardous fluids, or with opaque liquids, provide a metal meter tube.
   2. Performance requirements:
      a. Flow range:
         1) As specified in instrument datasheets or instrument index.
      b. Accuracy:
         1) Metal tube: Within 5.0 percent of range.
         2) Repeatability: 0.50 percent of range.
   3. Element:
      a. Metal tube with magnetic follower:
         1) Type 316 stainless steel.
      b. Turndown: 10 to 1.
      c. Process temperature:
         1) As indicated in the datasheet.
         2) Glass tube: 32 to 200 degrees Fahrenheit.
         3) Metal tube: -20 to 320 degrees Fahrenheit.
      d. Maximum process pressure:
         1) As indicated in the datasheet.
         2) Glass tube: 100 pounds per square inch gauge.

3) Metal tube: 450 pounds per square inch gauge.
4) Range:
a) As indicated in the datasheet.

e. Float:
1) Design to provide the widest possible immunity band change for lowest pressure loss.
2) Metal tube rotameters: Float with encapsulated magnet.

4. Components:
a. Seals: O-rings or packing glands fully compatible with process fluid.
b. Integral needle valve for flow control.

5. Scale:
a. Metal tube: Dial indicator with rotatable magnet coupled to magnet encapsulated in rotameter float.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 CALIBRATION AND TESTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - FLOW MEASUREMENT: ROTAMETERS (VARIABLE AREA FLOWMETERS)

Rotameter

SPECIFICATION 40_71_43

PROJECT INFORMATION

PLANT POST POINT
PROJECT 202021
CUSTOMER BELLINGHAM
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	ROTAMETER				
FI-33088	340N101	**FLUID**	SEAL WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-2 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	1/2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	STAINLESS STEEL	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	316 SST
		PROCESS CONN. MAT'L	STAINLESS STEEL				

SECTION 40_71_79

FLOW MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Thermal dispersion flow switches.
   2. Piston type flow switches.
   3. Vane type flow switches.
   4. Shuttle flow switches.
   5. Magnetic flow switches.
   6. Doppler non-contact flow switch.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Thermal dispersion type:
      a. Fluid Components International LLC, FLT93.
      b. Kayden.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Flow Measurement: Switches.

B. Thermal dispersion type:
   1. General:
      a. Instrument uses a heated probe and a reference probe.
         1) Deviation in the amount of heat measured by the reference probe deviates beyond the setpoint and adjustable relay closes.

2) Switch:
a) Micro-processor based with continuous self-diagnostics, “Smart Heater” to prevent sensor failure, no mechanical jumpers or trim pots, and a 3-year warranty.

2. Performance requirements:
a. Accuracy:
1) Liquids: Within 0.5 percent reading or within 0.04 fps
b. Repeatability: Within 1 percent of setpoint range.
c. Response time: 0.5 to 2.5 seconds.
d. Adjustable bypass delay timer.
e. Adjustable range.

3. Switch characteristics:
a. Exposed parts: Powder coated aluminum housing.
b. Wetted parts:
1) Materials as recommended by the manufacturer and approved by the Engineer.
c. Power supply:
1) As indicated in the datasheets.
2) 115 VAC.
d. Operating temperature range:
1) As indicated in the datasheets.
e. Enclosure:
1) As indicated in the datasheets.
2) Non-hazardous area:
a) NEMA Type 4X.
3) Class I, Division 1 area:
a) Explosion-proof/Class I, Division 1 rated.
4) Class I, Division 2 area:
a) Explosion-proof/Class I, Division 1 rated.

2.05 ACCESSORIES

A. Provide sunshades for outdoor installations.

2.06 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to the manufacturer’s standard at a facility that is traceable to the NIST.
1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the Project Site.

B. Provide FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.03 CALIBRATION AND TESTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - FLOW MEASUREMENT: SWITCHES

Flow Switch

SPECIFICATION 40_71_79

PROJECT INFORMATION

PLANT POST POINT
PROJECT 202021
CUSTOMER BELLINGHAM
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
FSL-33088	340N101	**SERVICE**	THERMAL FLOW SWITCH				
FE-33088		**FLUID**	RAS	**HAZARDOUS APP**	N/A	**POWER**	120VAC-1P
		MEASURING PRINCIPLE	THERMAL	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	PLC-2
		SET POINT	300 GPM	**SWITCH ENCL. CLASS**	NEMA 4X	**OUTPUT**	RELAY
		PROCESS CONNECTION	M-NPT	**PRESSURE**	N/A	**RELAY FORM**	SPDT
		CONNECTION MATERIAL	STAINLESS STEEL	**TEMPERATURE**	N/A	**PLC**	PLC-2
		INSERTION LENGTH	[*]	**VISCOSITY**	N/A	**SURGE PROTECTION**	NO
		TYPICAL DETAILS	NF111				

SECTION 40_72_24

LEVEL MEASUREMENT: RADAR PULSE TIME OF FLIGHT (PTOF)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Non-contact radar (PTOF) level instruments.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations
   1. PTOF: Pulse Time of Flight.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Quality Control Submittals:
   1. Manufacturer's representative qualifications as specified in Section 01_75_17 - Commissioning.

C. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

C. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Ametek Drexelbrook, DR7400 Series.
   2. Endress+Hauser, Micropilot FMR51.
   3. Ohmart Vega, VegaPuls.
   4. Siemens/Milltronics, LR250.

2.04 MANUFACTURED UNITS

A. Pulse Time of Flight:
   1. General:
      a. Instrument emits radar pulses via a transmitter, with a frequency range of 6.3 GHz to 26 GHz.
      b. Pulses reflect from the surface being measured and are received back at the instrument via a sensor.

c. Instrument measures the pulse travel time between the transmitter, surface, and receiver to calculate the level.
d. Safety:
1) Shall not generate frequency waves with power levels hazardous to humans.

2. Performance requirements:
a. Accuracy: Level:
1) 0.25 inch.

3. Element:
a. Level element must conform to the process material compatibility as indicated in Attachment A - ISA Datasheet - Level Measurement: Radar Pulse Time of Flight (PTOF) or the Instrument Index.
b. Connections:
1) Process: Antenna design shall be suitable for mounting in a nozzle as indicated in Attachment A - ISA Datasheet - Level Measurement: Radar Pulse Time of Flight (PTOF) or the Instrument Index.
2) Design shall be such that product condensation on the antenna shall not affect the performance of the gauge. It shall be possible to choose between parabolic-, cone-, or rod-shaped antennas.

4. Transmitter:
a. Microprocessor-based signal converter/transmitter.
b. Power supply:
1) As indicated in the datasheets.
2) 24 VDC - 2-wire loop powered.
c. Outputs:
1) As indicated in the datasheets.
2) Isolated 4-20 mA DC.
d. Backlit digital display for level or volume.
e. Self-diagnostics and automatic data checking.
f. Signal integrity:
1) Immune to radio frequency and electromagnetic interference with field strength of 15 volts/meter or less over a frequency range of 50 Hz to 460 MHz.
2) Able to ignore momentary level spikes or momentary loss of echo and indicate loss of echo condition on indicating transmitter unit.
g. Protected terminals and fuses in a separate compartment, which isolates field connection from electronics.
1) Indication: Local - 5-digit display.
h. Enclosure:
1) As indicated in the datasheets.
2) Class I, Division 1 area:
a) Explosion-proof/Class I, Division 1 rated.
b) NEMA 4X with intrinsic safe circuits.
i. Electrical connection: 1/2-inch male NPT.

2.05 ACCESSORIES

A. Software: Provide Windows based PC software for configuration and echo mapping.

B. Provide sun shield for outdoor installations.

2.06 SOURCE QUALITY CONTROL

A. Factory calibrate each level transmitter at a facility that is traceable to NIST.

B. Provide complete documentation covering the traceability of calibration instruments.

C. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 CALIBRATION AND TESTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

3.05 ADJUSTING

A. Verify factory calibration of instruments in accordance with the manufacturer’s instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.06 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - LEVEL MEASUREMENT: RADAR PULSE TIME OF FLIGHT (PTOF)

Level Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	LIT-44001 (LE-44001)		
SPECIFICATION NUMBER	40_72_24	**MEASURING PRINCIPLE**	RADAR PTOF
DRAWING NUMBER	440N101	**PLC**	PLC-420
SERVICE	RADAR	**TYPICAL DETAILS**	NL153

CONNECTION

PROCESS CONNECTION	FLANGE MOUNT

FLUID

LEVEL RANGE	0-28 FT	**TEMPERATURE**	N/A

ELEMENT

ELEMENT TAG NO.	LE-44001	**ENCLOSURE CLASS**	NEMA 4X
ELEMENT HAZ. MATERIALS	CLASS I, DIV 1	**ELEMENT MATERIAL**	MFR. STD.
SUBMERGENCE DETECTION	NO	**TEMPERATURE COMP.**	NO
HEATED ELEMENT	NO		

TRANSMITTER

TRANSMITTER TAG NO.	LIT-44001	**HAZARDOUS APPROVALS**	N/A
MOUNTING	INTEGRAL	**ENCLOSURE CLASS**	NEMA 4X
POWER	[*]	**OUTPUT**	4-20 MA
AMBIENT TEMPERATURE	80 DEG F DEG F	**MEASUREMENT APPL**	LEVEL
SURGE PROTECTION	YES		

NOTES

[*]

Level Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	LIT-44005 (LE-44005)		
SPECIFICATION NUMBER	40_72_24	**MEASURING PRINCIPLE**	RADAR PTOF
DRAWING NUMBER	440N102	**PLC**	PLC-420
SERVICE	RADAR	**TYPICAL DETAILS**	NL153

CONNECTION

PROCESS CONNECTION	FLANGE MOUNT

FLUID

LEVEL RANGE	0-28 FT	**TEMPERATURE**	N/A

ELEMENT

ELEMENT TAG NO.	LE-44005	**ENCLOSURE CLASS**	NEMA 4X
ELEMENT HAZ. MATERIALS	CLASS I, DIV 1	**ELEMENT MATERIAL**	MFR. STD.
SUBMERGENCE DETECTION	NO	**TEMPERATURE COMP.**	NO
HEATED ELEMENT	NO		

TRANSMITTER

TRANSMITTER TAG NO.	LIT-44005	**HAZARDOUS APPROVALS**	N/A
MOUNTING	INTEGRAL	**ENCLOSURE CLASS**	NEMA 4X
POWER	[*]	**OUTPUT**	4-20 MA
AMBIENT TEMPERATURE	80 DEG F DEG F	**MEASUREMENT APPL**	LEVEL
SURGE PROTECTION	YES		

NOTES

[*]

SECTION 40_72_76

LEVEL MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ball float level switch.
   2. Capacitance level switch.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Manufacture instrument facilities certified to the quality standards of ISO 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or Specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Ball float level switch:
      a. Anchor Scientific Inc., Ecofloat/Solofloat.
      b. E+H, Liquifloat T FTS20.
      c. Evoqua Water Technologies, 9G-EF.
      d. Xylem-Flygt, Model ENM-10.

2.04 MANUFACTURED UNITS

A. Ball float level switch:
   1. Encapsulated body with a switch to determine position of float.
   2. Outputs:
      a. Power supply.
      b. Relay outputs.
      c. 1 Form C contact.
      d. Rated at 6 amps at 120 VAC.
      e. Programmable for adjustable hysteresis.

3. Element:
    a. Mechanical switch encapsulated in waterproof floating ball of nominal diameter, supported by flexible PVC cable and jacket or heavy neoprene.
    b. Length of the PVC cable shall be, at a minimum, equal to sump depth plus 5 feet.
    c. Float: Provide Type 316 stainless steel or polypropylene, maximum 5.5 inches in diameter.
    d. An operating temperature rating: -4 degrees Fahrenheit to 185 degrees Fahrenheit.
    e. Mercury switches are not acceptable.
    f. Suspend ball float and adjust for level setpoint as required.
    g. Lead wires: Mounted in flexible waterproof PVC cable from switch to junction box terminals without splices.
    h. Provide the number of floats per level system as indicated on the Drawings.
4. Switch:
    a. Power supply:
        1) None.
    b. Outputs:
        1) As indicated in the datasheets.
        2) Single pole double throw contacts rated 10 amps resistive at 120 VAC.
    c. Enclosure:
        1) As indicated in the datasheets.
        2) Non-hazardous area:
            a) NEMA Type 4X.
        3) Class I Division 1 area:
            a) Explosion-proof/Class I Division 1 rated.
            b) NEMA 4X with intrinsic safe circuits.
        4) For more information, see Attachment A - ISA Datasheet - Level Measurement: Switches.
5. Components:
    a. Floats shall include Type 316 stainless steel clamp and brackets and 1/4-inch cable to allow testing of the float without entering the basin or wet well.
    b. Provide strain relief at both ends of the float cable.

B. Capacitance level switch:
1. Shall be made up of a control relay, mechanically rigid and rugged non-metallic probe and probe housing.
2. Switch:
    a. Provide a rigid, non-metallic element.
    b. Control relay senses the liquid level by capacitance measurement between the electrode probe, the process liquid, and the equipment ground:
        1) Power supply:
            a) As indicated in the datasheets.
            b) 120 VAC.
        2) Outputs:
            a) Relay outputs:
                (1) As indicated in the datasheets.
                (2) 1 Form C contact.
                (3) Rated at 6 amps at 120 VAC.

(4) Programmable for adjustable hysteresis.
(5) Configurable for fail-safe operation.

c. Electrical connection: One 1/2-inch NPT conduit entry.
d. Enclosure:
   1) As indicated in the datasheets.
   2) Class I Division 1 area:
      a) Explosion-proof/Class I Division 1 rated.
   3) For more information, see Attachment A - ISA Datasheet - Level Measurement: Switches.

2.05 SOURCE QUALITY CONTROL

A. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.03 CALIBRATION AND TESTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be as indicated on the Drawings, as specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - LEVEL MEASUREMENT: SWITCHES

Level Switch

SPECIFICATION 40_72_76

PROJECT INFORMATION

PLANT POST POINT
PROJECT 202021
CUSTOMER BELLINGHAM
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	CAPACITANCE				
LSH-44002	440N101	**FLUID**	BLENDED SLUDGE	**HAZARDOUS APP**	CLASS I, DIV 1	**POWER**	120VAC-1P
LE-44002		**MEASURING PRINCIPLE**	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	PCM
		SET POINT	27 FT	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL117	**ENCL. MATERIAL**	MFR. STD.	**PLC**	PLC-420
		SURGE PROTECTION	NO				

TAG	P&ID	SERVICE	CAPACITANCE				
LSH-44006	440N102	**FLUID**	BLENDED SLUDGE	**HAZARDOUS APP**	CLASS I, DIV 1	**POWER**	120VAC-1P
LE-44006		**MEASURING PRINCIPLE**	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	PCM
		SET POINT	27 FT	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL117	**ENCL. MATERIAL**	MFR. STD.	**PLC**	PLC-420
		SURGE PROTECTION	NO				

SECTION 40_73_13

PRESSURE/VACUUM MEASUREMENT: GAUGES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pressure/vacuum gauges.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B40.100 - Pressure Gauges and Gauge Attachments.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. Accessories.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments specified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Ametek U.S. Gauge.
   2. Ashcroft:
      a. Maximum pressure less than 10 pounds per square inch: Model 1188
         1) If a stainless steel dial casing is required:
            a) Model 1009.
      b. Maximum pressure greater than or equal to 10 pounds per square inch: Model 1279
         1) If a stainless steel dial casing is required:
            a) Model 1009.
   3. Wika, Model XSEL type 232.34.

2.04 MANUFACTURED UNITS

A. General:
   1. Pressure gauge assembly shall include pressure sensing element, gauge case, and dial mechanism.

B. Performance requirements:
   1. Pressure range:
      a. As specified in the Contract Documents.
   2. Accuracy:
      a. Grade 2A, as defined by ASME B40.100.

b. Within 1.0 percent of span after friction errors are eliminated by tapping or vibration.
c. Maximum allowable friction inaccuracy: Within 1.0 percent of span.

3. Element:
   a. Where the maximum pressure is less than 10 pounds per square inch, provide socket and bellows; for all other pressure ranges, employ a Bourdon® tube.
   b. Socket tips for bellows and Bourdon® tube:
      1) Materials: Type 316 stainless steel.
   c. Overpressure: Minimum 130 percent of maximum range pressure without damage to gauge or sensing element.
   d. Wetted materials:
      1) As indicated in the datasheets.
      2) Type 316 stainless steel.
4. Dial gauge:
   a. Dial size: 4-1/2 inches.
   b. Dial case material:
      1) As indicated in the datasheets.
      2) Maximum pressure less than 10 pounds per square inch:
         a) Phenolic
      3) Maximum pressure greater than or equal to 10 pounds per square inch:
         a) Stainless steel
   c. Provide safety gauge with safety blow out through the back or top of the unit.
   d. Dial face: Gasketed shatterproof glass or polycarbonate.
   e. Provide gauge locks on pressure gauges directly connected to diaphragm seals.
   f. Provide gauge locks where possible.
   g. Connection and mounting:
      1) Direct mounted and suitable for outdoor installation.
      2) 1/2-inch NPT.
      3) Connection material:
         a) As indicated in the datasheets.
         b) Stainless steel.
   h. Pointer: Externally adjustable.

2.05 ACCESSORIES

A. Pulsation dampeners and snubbers:
   1. As indicated in the datasheets.
   2. Provide with each pressure gauge installed on discharge of positive displacement type pump.
   3. Provide piston-type snubber if pressure spikes will exceed 130 percent of gauge maximum range.
   4. Mount integrally to the pressure gauge.
   5. Connection: 1/2-inch NPT.
   6. Provide diaphragm seals as specified in the Contract Documents and/or as indicated in the datasheets.
   7. Diaphragm seal and pressure gauge shall be assembled by the manufacturer and shipped as an assembly.

B. Furnish instrument isolation as indicated in the datasheets and specified in Section 40_73_64 - Pressure/Vacuum Measurement: Instrument Valves:
   1. Mount isolation device integrally to the instrument.
   2. Isolation device and instrument shall be assembled by the manufacturer and shipped as an assembly.

C. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.06 SOURCE QUALITY CONTROL

A. Factory calibrate each pressure gauge at a facility that is traceable to the NIST.

B. Provide complete documentation covering the traceability of calibration instruments.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 CALIBRATION AND TESTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 ADJUSTING

A. Verify factory calibration of instruments in accordance with the manufacturer's instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.05 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - PRESSURE/VACUUM MEASUREMENT: GAUGES

Pressure Gauge

SPECIFICATION 40_73_13

PROJECT INFORMATION

PLANT POST POINT
PROJECT 202021
CUSTOMER BELLINGHAM
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI-33088	340N101	**SERVICE**	PRESSURE INDICATOR				
		FLUID	SEAL WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	316L STAINLESS STEEL
		TEMPERATURE	[*]	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	2-VALVE MANIFOLD
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	N/A
		PRESSURE RANGE:	0-100 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI, 0-230 FT H20	**OPTIONS**	[*]	**AMBIENT TEMP**	[*]
TAG	**P&ID**						
PI-33089	340N101	**SERVICE**	PRESSURE INDICATOR				
		FLUID	RAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	316L STAINLESS STEEL
		TEMPERATURE	70 DEG F	**ISOLATION SEALS**	ANNULAR	**INSTRUMENT VALVES**	N/A
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	N/A
		PRESSURE RANGE:	0-60 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-60 PSI	**OPTIONS**	SNUBBER	**AMBIENT TEMP**	70 DEG F
TAG	**P&ID**						
PI-34033	050N102	**SERVICE**	PRESSURE INDICATOR				
		FLUID	WAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	N/A
		TEMPERATURE	70 DEG F	**ISOLATION SEALS**	ANNULAR	**INSTRUMENT VALVES**	N/A
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	N/A
		PRESSURE RANGE:	0-160 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	70 DEG F
TAG	**P&ID**						
PI-34034	050N102	**SERVICE**	PRESSURE INDICATOR				
		FLUID	WAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	316L STAINLESS STEEL
		TEMPERATURE	70 DEG F	**ISOLATION SEALS**	ANNULAR	**INSTRUMENT VALVES**	N/A
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	N/A
		PRESSURE RANGE:	0-160 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	SNUBBER	**AMBIENT TEMP**	70 DEG F

Pressure Gauge

SPECIFICATION 40_73_13

PROJECT INFORMATION

PLANT POST POINT
PROJECT 202021
CUSTOMER BELLINGHAM
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE					
PI-53061	530N102	PRESSURE INDICATOR					
		FLUID	BLENDED SLUDGE	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	316L STAINLESS STEEL
		TEMPERATURE	70 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	316L STAINLESS STEEL
		PRESSURE RANGE:	30" HG VAC TO 15 PSIG	**TYPICAL DETAILS**	NP501	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG/15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	70 DEG F

TAG	P&ID	SERVICE					
PI-53062	530N103	PRESSURE INDICATOR					
		FLUID	BLENDED SLUDGE	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	316L STAINLESS STEEL
		TEMPERATURE	70 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	316L STAINLESS STEEL
		PRESSURE RANGE:	30" HG VAC TO 15 PSIG	**TYPICAL DETAILS**	NP501	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG/15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	70 DEG F

SECTION 40_73_23

PRESSURE/VACUUM MEASUREMENT: DIRECT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pressure transmitters and indicators.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Calibrated range: Range that the pressure transmitter is configured to measure.
      a. Low end of the calibrated range must be greater than the lower range value (LRV) of the transmitter.
      b. High end of the calibrated range must be less than or equal to the upper range value (URV).
      c. Calibrated range corresponds to the flow signal sent from the transmitter.
   2. Lower range value (LRV): Lowest pressure that the pressure transmitter is capable of measuring.
   3. Upper range value (URV): Highest pressure that the pressure transmitter is capable of measuring.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.

b. Location within the process.
c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.09 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.10 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
1. ABB, 266 Series.
2. Emerson, Rosemount 2051 Series with high performance option.
3. Emerson, Rosemount 3051 Series.

4. Endress & Hauser, Cerabar S Series.
5. Yokogawa, EJA Series.

2.04 MANUFACTURED UNITS

A. Pressure transmitters - direct:
   1. General:
      a. Pressure transmitter assembly shall include a diaphragm type pressure transducer and microprocessor-based transmitter for measurement of gauge, vacuum, or absolute pressure.
   2. Performance requirements:
      a. Maximum ratio of total instrument range to calibrated span: 10 to 1.
      b. Accuracy:
         1) Reference accuracy: Within 0.075 percent of calibrated span, including effects of hysteresis, nonlinearity, and repeatability.
         2) Total performance accuracy: Within 0.30 percent of calibrated span, including reference accuracy effects, static pressure and ambient temperature effects.
         3) Stability: Within 0.15 percent of upper range limit over 5 years.
   3. Element:
      a. Diaphragm type transducer integral to pressure transmitter.
      b. Diaphragm material: Stainless steel or ceramic.
      c. Process material compatibility:
         1) Verify material compatibilities with the instrument manufacturer.
      d. Process connection: As specified in Attachment A - ISA Datasheet - Pressure/Vacuum Measurement: Direct.
   4. Transmitter:
      a. Power supply:
         1) As indicated in the datasheets.
         2) 24 VDC - 2 wire loop powered.
      b. Outputs:
         1) As indicated in the datasheets.
         2) Isolated 4-20 mA DC
      c. Provided with electronic microprocessor.
      d. Adjustments: Adjustable electronic zero and span, with elevated or suppressed zero as required by application. Adjustment shall be possible without mechanical fulcrum points or handheld configurator.
      e. Local display:
         1) 5-digit LCD.
         2) Scaled in engineering units.
      f. Enclosure:
         1) As indicated in the datasheets.
         2) Non-hazardous area:
            a) NEMA Type 4X.
         3) Class I, Division 1 area:
            a) Explosion-proof/Class I, Division 1 rated.
            b) NEMA Type 4X with intrinsic safe circuits.
      g. Over range protection: To maximum process line pressure.
      h. Conduit: 1/2-inch male NPT.

5. Components:
    a. Transmitter mounting:
        1) As indicated in the datasheets.
        2) Provide necessary hardware for transmitter mounting.

2.05 ACCESSORIES

A. Furnish instrument isolation as indicated in the datasheets and specified in Section 40_73_64 - Pressure/Vacuum Measurement: Instrument Valves:
    1. Mount isolation device integrally to the instrument.
    2. Isolation device and instrument shall be assembled by the manufacturer and shipped as an assembly.

B. Provide remote or integral diaphragm seals as indicated on the Drawings or as indicated in the datasheets.

C. Provide sunshades for outdoor installations.

D. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.06 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to the manufacturer's standard at a facility that is traceable to the NIST.
    1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the Project Site.

B. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 CALIBRATION AND TESTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - PRESSURE/VACUUM MEASUREMENT: DIRECT

Pressure Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	PIT-42001 (PE1-42001)		
SPECIFICATION NUMBER	40_73_23	**MEASURING PRINCIPLE**	DIRECT
DRAWING NUMBER	420N101	**PLC**	PLC-420
SERVICE	PRESSURE TRANSMITTER	**TYPICAL DETAILS**	[*]

CONNECTION

CONNECTION TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE

FLUID

FLUID	BLENDED SLUDGE	**PRESSURE RANGE**	0-200 PSIG
TEMPERATURE	70 DEG F		

ELEMENT

ELEMENT TAG NO.	PE1-42001	**SEAL TYPE**	DIAPHRAGM
ENCLOSURE CLASS	NEMA 4X	**DIAPHRAGM MATERIAL**	MFR. STD.
HAZARDOUS APPROVALS	N/A	**BOTTOM HOUSING MAT.**	316L STAINLESS STEEL

TRANSMITTER

TRANSMITTER TAG NO.	PIT-42001	**AMBIENT TEMPERATURE**	[*]
MOUNTING	INTEGRAL	**OUTPUT**	4-20 MA
ENCLOSURE CLASS	NEMA 4X	**SURGE PROTECTION**	NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	PIT-42004 (PE1-42004)		
SPECIFICATION NUMBER	40_73_23	**MEASURING PRINCIPLE**	DIRECT
DRAWING NUMBER	420N102	**PLC**	PLC-420
SERVICE	PRESSURE TRANSMITTER	**TYPICAL DETAILS**	[*]

CONNECTION

CONNECTION TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE

FLUID

FLUID	BLENDED SLUDGE	**PRESSURE RANGE**	0-200 PSIG
TEMPERATURE	[*]		

ELEMENT

ELEMENT TAG NO.	PE1-42004	**SEAL TYPE**	DIAPHRAGM
ENCLOSURE CLASS	NEMA 4X	**DIAPHRAGM MATERIAL**	316L STAINLESS STEEL
HAZARDOUS APPROVALS	N/A	**BOTTOM HOUSING MAT.**	316L STAINLESS STEEL

TRANSMITTER

TRANSMITTER TAG NO.	PIT-42004	**AMBIENT TEMPERATURE**	[*]
MOUNTING	INTEGRAL	**OUTPUT**	4-20 MA
ENCLOSURE CLASS	NEMA 4X	**SURGE PROTECTION**	NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	PIT-42002 (PE2-42002)		
SPECIFICATION NUMBER	40_73_23	**MEASURING PRINCIPLE**	DIRECT
DRAWING NUMBER	420N101	**PLC**	PLC-420
SERVICE	PRESSURE TRANSMITTER	**TYPICAL DETAILS**	[*]

CONNECTION

CONNECTION TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE

FLUID

FLUID	BLENDED SLUDGE	**PRESSURE RANGE**	0-200 PSIG
TEMPERATURE	70 DEG F		

ELEMENT

ELEMENT TAG NO.	PE2-42002	**SEAL TYPE**	DIAPHRAGM
ENCLOSURE CLASS	NEMA 4X	**DIAPHRAGM MATERIAL**	316L STAINLESS STEEL
HAZARDOUS APPROVALS	N/A	**BOTTOM HOUSING MAT.**	316L STAINLESS STEEL

TRANSMITTER

TRANSMITTER TAG NO.	PIT-42002	**AMBIENT TEMPERATURE**	[*]
MOUNTING	INTEGRAL	**OUTPUT**	4-20 MA
ENCLOSURE CLASS	NEMA 4X	**SURGE PROTECTION**	NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	PIT-42005 (PE2-42005)		
SPECIFICATION NUMBER	40_73_23	**MEASURING PRINCIPLE**	DIRECT
DRAWING NUMBER	420N102	**PLC**	PLC-420
SERVICE	PRESSURE TRANSMITTER	**TYPICAL DETAILS**	[*]

CONNECTION

CONNECTION TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE

FLUID

FLUID	BLENDED SLUDGE	**PRESSURE RANGE**	0-200 PSIG
TEMPERATURE	70 DEG F		

ELEMENT

ELEMENT TAG NO.	PE2-42005	**SEAL TYPE**	DIAPHRAGM
ENCLOSURE CLASS	NEMA 4X	**DIAPHRAGM MATERIAL**	MFR. STD.
HAZARDOUS APPROVALS	N/A	**BOTTOM HOUSING MAT.**	316L STAINLESS STEEL

TRANSMITTER

TRANSMITTER TAG NO.	PIT-42005	**AMBIENT TEMPERATURE**	[*]
MOUNTING	INTEGRAL	**OUTPUT**	4-20 MA
ENCLOSURE CLASS	NEMA 4X	**SURGE PROTECTION**	NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	PIT-53061 (PE2-53061)		
SPECIFICATION NUMBER	40_73_23	**MEASURING PRINCIPLE**	DIRECT
DRAWING NUMBER	530N102	**PLC**	RIO-53A
SERVICE	PRESSURE TRANSMITTER	**TYPICAL DETAILS**	[*]

CONNECTION

CONNECTION TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE

FLUID

FLUID	BLENDED SLUDGE	**PRESSURE RANGE**	0-150 PSIG
TEMPERATURE	70 DEG F		

ELEMENT

ELEMENT TAG NO.	PE2-53061	**SEAL TYPE**	DIAPHRAGM
ENCLOSURE CLASS	NEMA 4X	**DIAPHRAGM MATERIAL**	316L STAINLESS STEEL
HAZARDOUS APPROVALS	N/A	**BOTTOM HOUSING MAT.**	316L STAINLESS STEEL

TRANSMITTER

TRANSMITTER TAG NO.	PIT-53061	**AMBIENT TEMPERATURE**	70 DEG F
MOUNTING	INTEGRAL	**OUTPUT**	4-20 MA
ENCLOSURE CLASS	NEMA 4X	**SURGE PROTECTION**	NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	PIT-53062 (PE2-53062)		
SPECIFICATION NUMBER	40_73_23	**MEASURING PRINCIPLE**	DIRECT
DRAWING NUMBER	530N103	**PLC**	RIO-53A
SERVICE	PRESSURE TRANSMITTER	**TYPICAL DETAILS**	[*]

CONNECTION

CONNECTION TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE

FLUID

FLUID	BLENDED SLUDGE	**PRESSURE RANGE**	0-150 PSIG
TEMPERATURE	70 DEG F		

ELEMENT

ELEMENT TAG NO.	PE2-53062	**SEAL TYPE**	DIAPHRAGM
ENCLOSURE CLASS	NEMA 4X	**DIAPHRAGM MATERIAL**	316L STAINLESS STEEL
HAZARDOUS APPROVALS	N/A	**BOTTOM HOUSING MAT.**	316L STAINLESS STEEL

TRANSMITTER

TRANSMITTER TAG NO.	PIT-53062	**AMBIENT TEMPERATURE**	70 DEG F
MOUNTING	INTEGRAL	**OUTPUT**	4-20 MA
ENCLOSURE CLASS	NEMA 4X	**SURGE PROTECTION**	NO

NOTES

[*]

SECTION 40_73_36

PRESSURE/VACUUM MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pressure/vacuum switches.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. Accessories.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments specified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. Mechanical type pressure switch: One of the following or equal:
   1. ASCO, S-Series.
   2. Ashcroft, B Series.
   3. United Electric, Controls Series.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Pressure/Vacuum Measurement: Switches.

B. Mechanical type pressure switches:
   1. General:
      a. Diaphragm or diaphragm-sealed piston type.
   2. Performance requirements:
      a. Pressure range:
         1) As indicated in the datasheets.
      b. Accuracy:
         1) Within 1.0 percent of range.
      c. Repeatability:
         1) Within 1.0 percent of range.

3. Element:
    a. Type: Diaphragm, diaphragm-sealed piston, or Bourdon® tube.
    b. Overpressure:
        1) Minimum 130 percent of maximum range pressure without damage to switch or sensing element.
        2) Minimum 400 percent of nominal range without leakage or rupture.
    c. Sensing element shall not require ambient temperature compensation.
    d. Wetted materials:
        1) As indicated in the datasheets.
        2) Stainless steel
    e. Setpoint:
        1) As indicated in the datasheets.
        2) Single.
        3) Switch shall activate at setpoint on increasing pressure for high-pressure alarm applications and on decreasing pressure for low-pressure alarm applications.
    f. Deadband.
        1) As indicated in the datasheets.
        2) Fixed.
    g. Switch elements:
        1) As indicated in the datasheets.
        2) Snap acting.
            a) Single-pole double-throw (SPDT).
        1) As indicated in the datasheets.
        2) Hermetically sealed when installed in Class I, Division 2 area.
        3) Rated at 5 A, 125/250 VAC.
        1) Resets:
            a) As indicated in the datasheets.
            b) Automatic.
    h. Enclosure: Epoxy coated:
        1) As indicated in the datasheets.
        Non-hazardous area:
            a) NEMA Type 4X.
        2) Class I, Division 1 area:
            a) Explosion-proof/Class I, Division 1 rated.
            b) NEMA Type 4X with intrinsic safe circuits.
    i. Switch mounting:
        1) As indicated in the datasheets.
        2) Process connection: 1/2-inch NPT.
4. Components:
    a. Provide necessary hardware for pressure switch mounting.

2.05 ACCESSORIES

A. Pulsation dampeners and snubbers:
    1. Provide with each pressure switch installed on discharge of positive displacement type pump.
    2. Materials: Stainless steel.
    3. Mount integrally to the pressure switch.
    4. Connection: 1/2-inch NPT.

B. Provide diaphragm seals as specified in the datasheets or as indicated on the Drawings and as specified in Section 40_73_63 - Pressure/Vacuum Measurement: Diaphragm and Annular Seals:
   1. Diaphragm seal and pressure switch shall be assembled by the manufacturer and shipped as an assembly.

C. Furnish instrument isolation as indicated in the datasheets and specified in Section 40_73_64 - Pressure/Vacuum Measurement: Instrument Valves:
   1. Mount isolation device integrally to the instrument.
   2. Isolation device and instrument shall be assembled by the manufacturer and shipped as an assembly.

D. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.06 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to the manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the Project Site.

B. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper installation of instruments.

3.02 CALIBRATION AND TESTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.03 ADJUSTING

A. Verify factory calibration of instruments in accordance with the manufacturer's instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments specified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - PRESSURE/VACUUM MEASUREMENT: SWITCHES

Pressure Switch

SPECIFICATION 40_73_36

PROJECT INFORMATION

PLANT POST POINT
PROJECT 202021
CUSTOMER BELLINGHAM
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE					
PSL-33088	340N101	PRESSURE SWITCH LOW					
PE-33088		**FLUID**	SEAL WATER	**HAZARDOUS APP**	N/A	**POWER**	[*]
		FLUID TEMPERATURE	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	MECHANICAL	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	50 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	PLC-2
		TYPICAL DETAILS	NP503	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	N/A	**SEAL TYPE**	N/A
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	N/A

TAG	P&ID	SERVICE					
PSH-34033	050N102	PRESSURE SWITCH HIGH					
PE-34033		**FLUID**	WAS	**HAZARDOUS APP**	N/A	**POWER**	[*]
		FLUID TEMPERATURE	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	MECHANICAL	**ELEMENT MATERIAL**	316L SST	**OUTPUT**	RELAY
		SET POINT	20 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	PLC-2
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	316L STAINLESS S	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	316L STAINLESS STEEL

TAG	P&ID	SERVICE					
PSH-34034	050N102	PRESSURE SWITCH HIGH					
PE-34034		**FLUID**	WAS	**HAZARDOUS APP**	N/A	**POWER**	[*]
		FLUID TEMPERATURE	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	MECHANICAL	**ELEMENT MATERIAL**	316L SST	**OUTPUT**	RELAY
		SET POINT	20 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	PLC-2
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	316L STAINLESS S	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	316L STAINLESS STEEL

Pressure Switch

SPECIFICATION 40_73_36

PROJECT INFORMATION

PLANT POST POINT
PROJECT 202021
CUSTOMER BELLINGHAM
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	PRESSURE SWITCH HIGH				
PSH-42002	420N101	FLUID	BLENDED SLUDGE	HAZARDOUS APP	N/A	POWER	[*]
PE1-42002		FLUID TEMPERATURE	N/A	ELEM. ENCL. CLASS	NEMA 4X	POWER LOCATION	LOOP
		MEASURING PRINCIPLE	MECHANICAL	ELEMENT MATERIAL	316L SST	OUTPUT	RELAY
		SET POINT	100 PSIG OPEN	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		ADJUSTABLE RANGE	[*]	ENCL. MATERIAL	MFR. STD.	PLC	PLC-420
		TYPICAL DETAILS	NP501	SURGE PROTECTION	NO	MANUAL RESET	NO
		CONN. MOUNTING	BOTTOM	BOTT. HOUSING MAT.	316L STAINLESS S	SEAL TYPE	DIAPHRAGM
		CONNECTON TYPE	M-NPT	INSTRUMENT VALVES	INSTRUMENT VALVE TREE	DIAPHRAGM/WET MAT	316L STAINLESS STEEL

TAG	P&ID	SERVICE	PRESSURE SWITCH HIGH				
PSH-42005	420N102	FLUID	BLENDED SLUDGE	HAZARDOUS APP	N/A	POWER	[*]
PE1-42005		FLUID TEMPERATURE	N/A	ELEM. ENCL. CLASS	NEMA 4X	POWER LOCATION	LOOP
		MEASURING PRINCIPLE	MECHANICAL	ELEMENT MATERIAL	316L SST	OUTPUT	RELAY
		SET POINT	150 PSIG OPEN	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		ADJUSTABLE RANGE	[*]	ENCL. MATERIAL	MFR. STD.	PLC	PLC-420
		TYPICAL DETAILS	NP501	SURGE PROTECTION	NO	MANUAL RESET	NO
		CONN. MOUNTING	BOTTOM	BOTT. HOUSING MAT.	316L STAINLESS S	SEAL TYPE	DIAPHRAGM
		CONNECTON TYPE	M-NPT	INSTRUMENT VALVES	INSTRUMENT VALVE TREE	DIAPHRAGM/WET MAT	316L STAINLESS STEEL

TAG	P&ID	SERVICE	PRESSURE SWITCH HIGH				
PSH-53061	530N102	FLUID	BLENDED SLUDGE	HAZARDOUS APP	N/A	POWER	[*]
PE1-53061		FLUID TEMPERATURE	N/A	ELEM. ENCL. CLASS	NEMA 4X	POWER LOCATION	LOOP
		MEASURING PRINCIPLE	MECHANICAL	ELEMENT MATERIAL	316L SST	OUTPUT	RELAY
		SET POINT	100 PSIG OPEN	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		ADJUSTABLE RANGE	[*]	ENCL. MATERIAL	MFR. STD.	PLC	RIO-53A
		TYPICAL DETAILS	NP501	SURGE PROTECTION	NO	MANUAL RESET	NO
		CONN. MOUNTING	BOTTOM	BOTT. HOUSING MAT.	316L STAINLESS S	SEAL TYPE	DIAPHRAGM
		CONNECTON TYPE	M-NPT	INSTRUMENT VALVES	INSTRUMENT VALVE TREE	DIAPHRAGM/WET MAT	316L STAINLESS STEEL

Pressure Switch

SPECIFICATION 40_73_36

PROJECT INFORMATION

PLANT POST POINT
PROJECT 202021
CUSTOMER BELLINGHAM
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	PRESSURE SWITCH HIGH				
PSH-53062	530N103	FLUID	BLENDED SLUDGE	HAZARDOUS APP	N/A	POWER	[*]
PE1-53062		FLUID TEMPERATURE	N/A	ELEM. ENCL. CLASS	NEMA 4X	POWER LOCATION	LOOP
		MEASURING PRINCIPLE	MECHANICAL	ELEMENT MATERIAL	316L SST	OUTPUT	RELAY
		SET POINT	100 PSIG OPEN	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		ADJUSTABLE RANGE	[*]	ENCL. MATERIAL	MFR. STD.	PLC	RIO-53A
		TYPICAL DETAILS	NP501	SURGE PROTECTION	NO	MANUAL RESET	NO
		CONN. MOUNTING	BOTTOM	BOTT. HOUSING MAT.	316L STAINLESS S	SEAL TYPE	DIAPHRAGM
		CONNECTON TYPE	M-NPT	INSTRUMENT VALVES	INSTRUMENT VALVE TREE	DIAPHRAGM/WET MAT	316L STAINLESS STEEL

TAG	P&ID	SERVICE	PRESSURE SWITCH LOW				
PSL-42001	420N101	FLUID	BLENDED SLUDGE	HAZARDOUS APP	N/A	POWER	[*]
PE2-42001		FLUID TEMPERATURE	N/A	ELEM. ENCL. CLASS	NEMA 4X	POWER LOCATION	LOOP
		MEASURING PRINCIPLE	MECHANICAL	ELEMENT MATERIAL	316L SST	OUTPUT	RELAY
		SET POINT	PSIG OPEN	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		ADJUSTABLE RANGE	[*]	ENCL. MATERIAL	MFR. STD.	PLC	PLC-420
		TYPICAL DETAILS	[*]	SURGE PROTECTION	NO	MANUAL RESET	NO
		CONN. MOUNTING	BOTTOM	BOTT. HOUSING MAT.	316L STAINLESS S	SEAL TYPE	DIAPHRAGM
		CONNECTON TYPE	M-NPT	INSTRUMENT VALVES	INSTRUMENT VALVE TREE	DIAPHRAGM/WET MAT	316L STAINLESS STEEL

TAG	P&ID	SERVICE	PRESSURE SWITCH LOW				
PSL-42004	420N102	FLUID	BLENDED SLUDGE	HAZARDOUS APP	N/A	POWER	[*]
PE2-42004		FLUID TEMPERATURE	N/A	ELEM. ENCL. CLASS	NEMA 4X	POWER LOCATION	LOOP
		MEASURING PRINCIPLE	MECHANICAL	ELEMENT MATERIAL	316L SST	OUTPUT	RELAY
		SET POINT	-5 PSIG OPEN	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		ADJUSTABLE RANGE	[*]	ENCL. MATERIAL	MFR. STD.	PLC	PLC-420
		TYPICAL DETAILS	[*]	SURGE PROTECTION	NO	MANUAL RESET	NO
		CONN. MOUNTING	BOTTOM	BOTT. HOUSING MAT.	316L STAINLESS S	SEAL TYPE	DIAPHRAGM
		CONNECTON TYPE	M-NPT	INSTRUMENT VALVES	INSTRUMENT VALVE TREE	DIAPHRAGM/WET MAT	316L STAINLESS STEEL

SECTION 40_73_63

PRESSURE/VACUUM MEASUREMENT: DIAPHRAGM AND ANNULAR SEALS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Diaphragm seals.
   2. Annular seals.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. American National Standards Institute (ANSI).

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Additional requirements:
   1. Product data:
      a. Manufacturer’s installation instructions.
      b. Seal type.
      c. Body materials.
      d. Diaphragm material.
      e. Fill fluid type.
      f. Seal size.
      g. Options.
      h. Process connection.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify the compatibility with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.

b. Location within the process.
c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Notify the Engineer if any installation condition does not meet the manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish a spare annular seal for every size provided in the project.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide seals identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. Diaphragm seals:
1. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch gauge: One of the following or equal:
a. Ashcroft:
1) Flushing connection: Type 741.
2) Without flushing connection: Type 740.
b. Mansfield and Green:
1) Flushing connection: Type SGT.
2) Without flushing connection: Type SBT.

c. Wika, Type L990.40.
d. Emerson, Rosemount.

2. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures greater than or equal to 15 pounds per square inch gauge: One of the following or equal:
   a. Ashcroft:
      1) Flushing connection: Type 201.
      2) Without flushing connection: Type 200.
   b. Mansfield and Green:
      1) Flushing connection: Type SG.
      2) Without flushing connection: Type SB.
   c. Wika:
      1) Type L990.10.
      2) Saddle mount: L910.ZA.

B. Annular seals:
   1. One of the following or equal:
      a. Ashcroft, Wafer Isolation Ring.
      b. Onyx Valve.
      c. Red Valve.

2.04 MANUFACTURED UNITS

A. Diaphragm seals:
   1. General:
      a. Diaphragm seal and pressure instrument shall be assembled by pressure instrument manufacturer and shipped as an assembly.
   2. Requirements:
      a. Seal type:
         1) Metallic diaphragm: Welded to upper housing.
         2) Elastomer diaphragm: Bonded to upper housing.
      b. Process connection:
         1) As indicated in the instrument datasheets.
      c. Instrument connection: 1/2-inch NPT.
      d. Material Construction:
         1) Type 316 stainless steel.
      e. Provide 1/4-inch flushing connection in diaphragm lower housing or provide flushing ring.
      f. Provide fill/bleed connection.
      g. Mounting: As indicated in the Contract Documents.
      h. Provide Type 316 stainless steel armored capillary for remote installations.
      i. Nuts and bolts: Type 316 stainless steel.
      j. Materials of construction:
         1) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch:
            a) Diaphragm: Type 316 stainless steel.
            b) Lower housing: Type 316 stainless steel.
            c) Upper housing: Manufacturer’s standard.
            d) Fill fluid: Silicone oil.

2) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures greater than 15 pounds per square inch:
   a) Diaphragm: Type 316 stainless steel.
   b) Lower housing: Type 316 stainless steel.
   c) Upper housing: Manufacturer's standard.
   d) Fill fluid: Silicone oil.
3) Engineer's approval.

B. Annular seals:
1. General:
   a. Inside diameter of annular seal shall provide uninterrupted flow:
      1) There shall be no dead ends or crevices.
      2) Process flow shall be sufficient to make the annular seal self-cleaning.
   b. The pressure sensing flexible cylinder shall measure pressure around the full inside circumference of the pipeline.
2. Requirements:
   a. Pressure rating: Equivalent to the ANSI flanges.
   b. Materials of construction:
      1) Inner flexible cylinder: Manufacturer's standard.
      2) Body:
         a) Carbon steel with epoxy coating.
         b) As indicated in the instrument datasheets.
         c) Type 316 stainless steel.
      3) Assembly flanges: To match adjacent piping.
      4) Fill fluid: Silicone oil.
   c. Nominal pipe size: As indicated on the Drawings.
   d. Process connection:
      1) As indicated in the instrument datasheets.
      2) Wafer
   e. Instrument connection: 1/2-inch NPT.
   f. Provide isolating needle valve between annular seal and pressure instrument.

PART 3 EXECUTION

3.01 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation System.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

C. Do not use Teflon™ thread seal tape on pressure instruments with silicone oil fill fluid.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning.

END OF SECTION

SECTION 40_73_64

PRESSURE/VACUUM MEASUREMENT: INSTRUMENT VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Instrument valve tree.
   2. Valve manifolds.
   3. Level sensor isolation valves.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Additional requirements:
   1. Product data:
      a. Instrument valve type.
      b. Body material.
      c. Size.
      d. Options.
   2. Shop Drawings:
      a. Mounting details for instrument valves.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the valves are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide valves manufactured at facilities certified to the quality standards of ISO 9001.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Protect valve manifolds and protective coatings from damage during handling and installation. Repair coating where damaged.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide valves and valve manifolds identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide valves and valve manifolds suitable for the installed Site conditions, including, but not limited to, material compatibility, process, and ambient temperatures.

2.03 MANUFACTURERS

A. Instrument valve tree as indicated in the Contract Documents.

B. Valve manifolds:
   1. One of the following or equal:
      a. Anderson Greenwood.
      b. Emerson, Rosemount.
      c. Hex Valve.
      d. Noshok.

C. Level sensor isolation valves:
   1. One of the following or equal:
      a. DeZURIK.
      b. Indu-Tech.
      c. PBM.

2.04 MANUFACTURED UNITS

A. Instrument valve tree as indicated in the Contract Documents.

B. Valve manifolds:
   1. General:
      a. Provide 2-valve, 3-valve, blowdown type 5-valve, or metering type 5-valve manifolds, as indicated in the datasheets.
      b. Valve manifolds shall have 1-piece bonnet with a metal-to-metal seal to the valve body below the bonnet threads.
   2. Requirements:
      a. Bonnet lock pin to prevent accidental loosening.
      b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
      d. Manifold valves shall have straight through portion for bi-directional flow and easy roddable cleaning.
      e. Manifold valves shall allow for direct or remote instrument mounting.
      f. Shall be able to withstand pressures up to 6,000 psi for soft seat valves and 10,000 psi for hard seat valves at maximum 200 degrees Fahrenheit.
      g. Materials of construction:
         1) Body material: Type 316 stainless steel.
         2) O-ring: Teflon™.
      h. 2-valve manifolds:
         1) 1 isolation valve and 1 drain/vent and calibration valve.
      i. 3-valve manifolds:
         1) 2 isolation valves and 1 equalizing valve for differential pressure applications.
         2) Plugged vent connections used for vent/drain or calibration.
      j. Blowdown 5-valve manifold:
         1) 2 isolation valves, 1 equalizing valve, 2 blowdown valves for differential pressure applications.
      k. Metering 5-valve manifold:
         1) 2 isolation valves, 2 equalizing valves, 1 vent/drain and calibration valve for differential pressure applications.

C. Level sensor isolation valves:
   1. General:
      a. Valve shall provide process isolation from level diaphragm.
      b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested, soft seat design with replaceable seat for soft seat valves.
   2. Requirements:
      a. Materials of construction:
         1) Body material: Type 316 stainless steel.
         2) Flange diameter size: 3 inches.

2.05 ACCESSORIES

A. Provide tube fitting, female NPT, or pipe butt weld connections if necessary.

B. Provide stainless steel concentric or eccentric pipe nipples when necessary.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location and verify the valve will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper installation of valves.

END OF SECTION

SECTION 40_75_59

ANALYZERS: SLUDGE DENSITY METER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Sludge density analyzers.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

C. Quality Control Submittals:
   1. Manufacturer's representative qualifications as specified in Section 01_75_17 - Commissioning.

D. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

1.04 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. The following or equal:
   1. Valmet, TS with 4G TCU.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Analyzers: Sludge Density Meter.

B. Flange sludge density meters:
   1. General:
      a. Non-nuclear device using the microwave phase shift technology to determine concentrations of solids (density) in the high-concentration sludge flowing through pipes.
      b. There shall be no upstream or downstream straight run piping requirement to maintain the meter accuracy.
   2. Performance requirements:
      a. Range: 0 to 35 percent density (total solids).
      b. Resolution: Within 0.001 percent density (total solids).
      c. Repeatability: Within 0.01 percent density (total solids).
   3. Element:
      a. Sensor enclosure:
         1) Junction box with watertight quick-disconnect signal and power couplings that permit easy removal of sensor and support assembly.
         2) Environmental rating: NEMA 4X.
      b. Process temperature: 0 to 100 degrees Celsius.
      c. Flow-through sensor.
      d. Material: Type 316 stainless steel, or equivalent.
      e. Glass-lined flow tube.
   4. Transmitter:
      a. Power supply:
         1) 120 VAC
         2) Max power consumption: 40 VA.
      b. Outputs:
         1) Isolated 4 to 20 mA DC with HART communication protocol.
         2) Solid state fault contact.
      c. Front-mounted indicator graduated in percent solids.
      d. LCD display.
      e. Status indicating LEDs.
      f. Analyzer/indicator units mounting:
         1) Wall or floor stand.
         2) A bubble exclusion function to reduce the effect of a sudden intrusion of bubbles in the process that could affect the accuracy of the meter.
      g. Automatic density range change capability to allow it to switch between 4 different density ranges by the activation of an external contact or analog signal.
      h. Capable of operating in process temperature conditions from 0 degrees Celsius to 50 degrees Celsius.
      i. Meter body shall be Type 316 stainless steel construction.
      j. Finish: Polyurethane.
   5. Transmitter shall be IP65 rated (watertight).

2.05 ACCESSORIES

A. Provide sunshade for outdoor installations.

2.06 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to the manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the Project Site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - ANALYZERS: SLUDGE DENSITY METER

Sludge Density

PROJECT INFORMATION

PLANT	POST POINT	**CUSTOMER**	BELLINGHAM
PROJECT	202021	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG	AIT-53011 (AE-53011)	**POWER LOCATION**	PCM
SPECIFICATION NUMBER	40_75_59	**MEASURING PRINCIPLE**	MICROWAVE PHASE SHIFT
DRAWING NUMBER	530N104	**PLC**	RIO-53A
SERVICE	SLUDGE DENSITY METER	**TYPICAL DETAILS**	NA901

GAS

FLUID	THICKENED SLUDGE	**PRESSURE**	175 PSIG
MEASUREMENT RANGE	0-10%	**TEMPERATURE**	70 DEG F

ELEMENT

ELEMENT TAG NO.	AE-53011	**HAZARDOUS APPROVALS**	N/A
ENCLOSURE CLASS	NEMA 4X	**PROCESS CONNECTION**	FLANGED
ELEMENT MATERIAL	316 SST		

TRANSMITTER

TRANSMITTER TAG NO.	AIT-53011	**SIGNAL OUTPUT**	AI
ENCLOSURE CLASS	NEMA 4X	**OUTPUT**	4-20 MA
TRANS. MOUNTING	REMOTE	**TRANS. HAZ APPROVALS**	N/A
POWER	120VAC-1P	**RELAY OPTIONS**	YES
SURGE PROTECTION	NO	**AMBIENT TEMPERATURE**	[*]

NOTES

[*]

SECTION 40_80_01

COMMISSIONING FOR INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Testing requirements that apply to process control and instrumentation systems for the entire Project.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations:
   1. PTO: Profibus Trade Organization.

C. Standards:
   1. Telecommunications Industry Association (TIA).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Complete end-to-end testing (CEET) - Signals are tested from the field device through the PLC program, the network, and all the way to the operator's HMI graphic screens.
   2. Loop validation tests - Signals are tested from the field device to the PLC.
   3. Permanent link: Fixed portion of cabling installed between an equipment outlet and its immediate distributor or between 2 distributors.
   4. Platform testing: Testing of the PLC and SCADA/HMI at the manufacturer's facility to demonstrate the program's functionality based upon specified and designed control requirements.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. General:
   1. Reference additional detailed test Submittal scheduling and prerequisite requirements as specified in the sequencing article of Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

C. Overall test plan:
   1. Develop the PCIS system test Submittals in consultation and cooperation with applicable Subcontractors.

2. Develop and submit an overall testing plan for the PCIS. Overall test plan to be reviewed and approved by the Engineer before detailed test plans, procedures, and forms will be reviewed.
3. Describe the test phases as they apply specifically to this Project and each process system.
4. Provide a preliminary testing schedule to show the sequence of tests and commissioning as they apply to each process system and each PLC.
5. Provide a description of factory tests. Describe what equipment will be included, what testing equipment will be used, and the simulator that will be used.
6. Provide examples of proposed forms and checklists.

D. Test procedures:
1. Develop and submit detailed test procedures to show that the integrated SCADA system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
2. Provide a statement of test objectives for each test.
3. Prepare specific procedures for each process system.
4. Describe sequentially the steps to be followed in verifying the correct operation of each process system, including features described in the loop descriptions, control strategies, and shown in the P&IDs. Implied or generic test procedures are not acceptable.
5. Specify who will perform the tests, specifically what testing equipment will be used (including serial numbers and NIST-traceable calibration), and how the testing equipment will be used.
6. Describe the expected role of the Engineer, as well as any requirements for assistance from the Owner's staff.
7. Provide the forms and checklists to be used.

E. Test forms:
1. Submit completed calibration forms, test forms, and checklists.
    a. Test forms shall include the detailed test procedures or shall include clear references to separate pages containing the complete test procedure applicable to each form. If references to procedures are used, the complete procedure shall be included with each test binder.
    b. Every page of each test form shall include Project name, date, time, name of person conducting the test, signature of person conducting the test, and for witnessed tests, place for signature of person (Engineer and Owner) witnessing the test.
    c. Sample test forms at the end of this Section show the minimum required content:
        1) Sample test forms have not been customized for this Project.
        2) Develop and submit test forms customized for the Project and meeting the specified test and Submittal requirements.

F. FAT procedure additional minimal requirements:
1. Prepare and submit a FAT procedure which includes:
    a. Control system testing block diagram.
    b. Estimated test duration.
    c. Details on the simulator construction, components, and operation.

G. Testing binders:
   1. Sub-system to be tested: Provide and submit a test binder containing test procedures and individual forms for the test. References to other documents for test procedures and requirements are not acceptable.
   2. Fill out in advance, headings and all other information known before the test.
   3. Include applicable test plan information, as well as a list of test prerequisites, test personnel, and equipment.
   4. Include or list reference material and provide separately at the time of the test.
   5. Record test results and verify that all test requirements and conditions have been met.

H. Furnish Commissioning Submittals listed below, as specified in this Section, and Section 01_75_17 - Commissioning:
   1. Manufacturer's representative qualifications.
   2. Owner Training.

I. Test reports:
   1. At the conclusion of each test, submit a complete test report, including test results and certifications.
   2. Include completed test binders, forms, and checklists.
   3. Submission, review, and acceptance of each test report is required before the start of the sub-system.

J. Furnish 4 CD/DVD copies of the following:
   1. Application software:
      a. Finalized fully annotated copy of programmed PLC logic in its native format.
      b. Cross-referenced index of PLC registers or points.

1.05 QUALITY ASSURANCE

A. Test personnel:
   1. Furnish qualified technical personnel to perform calibration, testing, and verification. Test personnel are required to be familiar with this Project and the equipment, software, and systems before being assigned to the test program.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation supervision:
   1. Provide as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning.

B. Testing and training phase:
1. Source Testing:
a. Manufacturer services: Provide as specified in the table below.

Section Number	Section Title	Source Testing (Witnessed or Non-Witnessed)
40_61_05 - Packaged Control System	Packaged Control System	Witnessed
40_61_15 - Control Strategies	Control Strategies	Witnessed
40_61_16.10 - Specific Control Strategies	Specific Control Strategies	Witnessed
40_67_01 - Control Systems - Panels, Enclosures, and Panel Components	Control Systems - Panels, Enclosures, and Panel Components	Witnessed
40_80_01 - Commissioning for Instrumentation and Controls	Commissioning for Instrumentation and Controls	Witnessed

b. Prerequisite requirements:
1) Engineer approval of the hardware and equipment Source Testing Submittal is required before proceeding to preliminary FAT.
c. Preliminary FAT (pre-FAT):
1) The purpose of the pre-FAT is to provide assurance that the HMI/SCADA system is ready for the full, witnessed FAT, in terms of both stability and functionality:
a) Debugging of software and troubleshooting of hardware shall occur during and before the pre-FAT, not during the FAT.
b) Fully test the HMI/SCADA system and fix deficiencies found before the FAT.
2) Conduct utilizing test procedures approved by the Engineer.
3) Owner shall have the right to witness any or all of the pre-FAT testing and shall be notified in writing 20 days before the start of the pre-FAT.
4) Submit a letter, signed by the Contractor's Project manager or company officer, certifying that integrated system hardware and software has been tested and confirmed to be fully operational and in compliance with the requirements specified in the Contract Documents and is fully ready for the full, witnessed FAT:
a) Attach the completed pre-FAT test forms, signed by the Contractor's staff.
5) Engineer approval of the pre-FAT Submittal is required before proceeding to FAT.
d. FAT hardware and communications testing:
1) Perform tests to show that the integrated system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
2) Complete PCIS system, including operator stations, servers, network equipment, printers, PCMs, PLCs, RTUs, LCPs, CCS, peripherals, communications equipment, and other HMI/SCADA equipment, shall

be assembled, connected, and software loaded for a fully functional FAT of the integrated system.

3) For any fault tolerant networks such as ring topology networks, disconnect each segment of the network individually to demonstrate proper failover and alarming at the HMI.
4) Testing simulation:
    a) Inputs and outputs shall be simulated and proper control and system operation shall be validated.
    b) Whenever supplied equipment is available, such as devices internal to the control panel, test input and output signals using the equipment. Simulation is not acceptable.
    c) FAT shall make use of simulators that contain switches, pilot lights, variable analog signal generators, and analog signal level displays, which shall be connected to the I/O points within the HMI/SCADA system.
        (1) Simulator may consist of a PLC, operating under an HMI/SCADA software package, or other approved software that has its I/O points wired to the PLC's I/O points.
        (2) Software operating on a PC may then act as the switches, pilot lights, variable analog signal generators, and analog signal level displays.
5) Additional source tests are specified in other sections of the instrumentation and control Specifications.
6) Owner shall have the right to witness any or all of the FAT testing and shall be notified in writing 20 days before the start of the FAT.
7) Verify communications between the hardware and the programmer's software comply with specified requirements:
    a) For systems that contain RTUs or remote communications with other devices, the complete communications system must be factory tested, including actual interfacing with telephone company equipment and/or the actual radios used for radio-based telemetry systems.
8) Panel inspections:
    a) Engineer will inspect each control panel for completeness, workmanship, fit and finish, and compliance with the Contract Documents and the accepted Shop Drawings:
        (1) Inspection to include, as a minimum: Layout, mounting, wire and data cable routing, wire tags, power supply, components and wiring, I/O components layout (including terminals, wiring and relays), device layout on doors and front panels, and proper ventilation operation.
    b) Inspection forms:
        (1) Provide panel inspection forms as part of the FAT procedures Submittal.
        (2) A sample FAT control panel form has been provided at the end of this Section.
9) I/O test:
    a) Engineer will verify that I/O is properly wired to field terminals and is properly mapped into the PLC and the rest of the SCADA system, including operator interface devices.

b) Test methodology:
   (1) Discrete inputs:
      (a) Apply appropriate input from simulator at panel terminal, observe input card indicator, observe data value at each indicated data address, and observe data received at field wiring terminals or operator interface screen.
   (2) Discrete outputs:
      (a) Issue commands from operator interface screen or PLC, verify output card indicator light, and measure response at field wiring terminals or multimeter.
   (3) Analog inputs:
      (a) Apply appropriate analog input signal at panel terminals on simulator, observe data value at each indicated data address, and observe data properly received at field wiring terminals or operator interface screen.
      (b) Check each point at 0 percent, 50 percent, and 100 percent of scale.
   (4) Analog outputs:
      (a) Enter scaled values in the output buffer file, observe the output data file value, and measure appropriate response at field wiring terminals or multimeter.
      (b) Check each point at 0 percent, 50 percent, and 100 percent of scale.

c) Test forms to include, but not be limited to, the following data:
   (1) PLC and panel number.
   (2) I/O type.
   (3) I/O tag name.
   (4) Rack/slot/number of I/O point.
   (5) Check-off for correct response for each I/O point.
   (6) Comments field.
   (7) Initials of individual performing test.
   (8) Date test was performed.
   (9) Witness signature lines.

10) System configuration test:
   a) Demonstrate and test the setup and configuration of operator stations, servers, development stations, and peripherals.
   b) Demonstrate utility software and functions, such as virus protection, backup, optical drive burning, network monitoring, etc.
   c) Demonstrate the proper operation of peripheral hardware.
   d) Demonstrate general HMI/SCADA functions.
   e) Demonstrate proper operation of log-on and other security access functions.
   f) Demonstrate the proper operation of historical data storage, trend, display, backup, and report functions.
   g) Test automatic fail over of redundant equipment.
   h) Demonstrate the proper operation of the alarm display and acknowledgement functions.
   i) For any fault tolerant networks, such as ring topology networks, disconnect each segment of the network individually to demonstrate proper failover and alarming.

j) Test forms:
(1) For each test, list the specification page and paragraph of the function demonstrated, and provide a description of the function.
(2) List the specific tests and steps to be conducted.
(3) For each function, list all of the different sub-functions or ways the function can be used, and provide a test check-off for each:
(a) Include signature and date lines.

11) Engineer approval of the FAT Communication Testing activities is required before proceeding to FAT Platform Testing.

e. FAT Platform Testing - Control logic test:
1) Verify the PLC, HMI, and SCADA, provides monitoring and control functionality based upon specified and designed control requirements.
2) Testing requirements:
a) Demonstrate each function described in the Control Strategies.
b) Demonstrate in detail how each function operates under a variety of operating scenarios:
(1) Test to verify the application of each general control strategy function to each specific control strategy or loop description.
c) Demonstrate the proper operation of the programming and configuration for each control strategy or loop description:
(1) Test each strategy or loop description on a sentence by sentence and function by function basis.
(2) Loops with similar or identical logic must each be tested individually.
(3) Test the boundaries of each numeric operator input by entering values outside of the allowable range.
d) Demonstrate the proper operation of digital communication links and networks.
(1) Verify each digital communication I/O point.
e) Failure testing: Demonstrate how the system responds to and recovers from abnormal conditions, including, but not limited to, equipment failure, operator error, communications subsystem error, communications failures, simulated/forced software lockups, power failure (both utility power and power to HMI and/or SCADA hardware), process equipment failure, and high system loading conditions.
3) Test forms:
a) Submit completed test forms for each loop, including, but not limited to, the fully revised and approved control strategy.
b) Identify the cause and effect as each I/O point is toggled through the simulator:
(1) Identify and track proper and/or improper operation of the loop.
c) Note any deficiencies or operational changes on the forms for correction and documentation:
(1) Include signature and date lines.
4) Engineer approval of the FAT Submittal is required prior to shipment of system components.

2. Owner Training:
    a. Perform Owner Training as specified in Section 01_75_17 - Commissioning.

Course Title	Minimum Course Length (Hours per Session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
System Overview	8	10	1
Operator Training - Basic	24	10	2
Operator Training - Advanced	16	5	2
PLC Hardware	16	4	1
PLC Software	32	6	1
Network Equipment	16	4	1

3. Training course requirements:
    a. System overview training:
        1) Furnish training courses that give the Owner's supervisory level personnel and overview of all elements of the PCIS system that focus on the overall functional aspect of elements of the control system and provide an understanding of the interaction of the various components.
        2) Furnish a training course that gives the Owner's supervisory level personnel and overview of the new Contractor-provided elements of the PCIS system. Focus on the overall functional aspects of each new elements of the control system, particularly the mechanical system vendor-provided control packages.
    b. Operator training:
        1) Furnish training courses that instruct system operators in the efficient operation of all aspects of the PCIS that include not only the general operation of the control system but also the operation of specific system features.
        2) Furnish training courses that instruct system operators in the efficient operation of Contractor-provided aspects of the PCIS that include not only the general operation of each control system but also the operation of specific system features.
        3) Operator's training shall include the following for each vendor package and programmable device:
            a) Control system overview: Architecture, equipment functions, software components, etc.
            b) Display navigation, overview, and types of displays.
            c) Process and equipment monitoring and control: Basic principles and operation.
            d) Logging ON and OFF the system and description of the security and access system.
            e) Alarm subsystem.
            f) Trending: Provide a thorough session on how to use trending functions.
            g) Reports: How to access, print, and review content.

h) Control strategies: Present an average 15-minute review of each control strategy, including a hands-on demonstration of screens and operator functions for each.
i) Instruction on the use of operational functionality alarm logging, trending, displays, database, reports, and control software developed for the Project and incorporated in the installed PCIS system.

c. PLC software training:
1) Furnish training on PLC software.
2) 2 types of training are required; basic and project-specific:
a) Basic PLC software training covers the principles of PLC programming and the specific features and function of the PLC products used on this Project, provided by one of the PLC manufacturer's certified trainers.
b) Project-specific PLC software training covers the programming conventions, new standardized software modules, specific control strategy programs, and documentation created for the Work performed under this Contract.
(1) This training includes the specific knowledge needed to modify, expand, duplicate, troubleshoot, and repair the PLC programs provided under this Contract, provided by a qualified member of the ICSC who is thoroughly familiar with the delivered system, and is one of the senior programmers who programmed the PLCs for this Project.

d. Network equipment training:
1) Furnish basic training on network hardware, switch and router configuration and software, and network monitoring software.
2) Include a detailed description and explanation of the installed network architecture, media, and functions.
3) Furnish an overview of the function and operation of each piece of network equipment.
4) Furnish training on network maintenance troubleshooting and repair.
5) Furnish training on how to install spare or off-line backup equipment.
6) Basic network overview:
a) Discuss a basic network overview for each site.
b) Discuss the architecture (loop, star, etc.), media redundancy, and items that are not readily apparent to staff.
c) Discuss how to monitor the network health through the HMI network screen.
d) Discuss both enterprise level networks, the PCS communications network, and the field network.
7) Ethernet switches:
a) Discuss the various types of switches (Layer 2, Layer 3, etc.).
b) Discuss switch health monitoring through the HMI.
c) Discuss the VLAN configuration (what ports should be used for what network, etc.).
d) Discuss testing procedures.

4. Installation testing:
a. Calibration:
1) Performed by the Contractor and ICSC.

2) Calibrate and adjust instruments, devices, valves, and systems, in accordance with the component manufacturer's instructions and as specified in these Contract Documents.
3) Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
    a) Discrete devices:
        (1) Calibrate and adjust devices for reliable operation and to avoid nuisance tripping.
    b) Ultrasonic and radar level devices:
        (1) Provide echo transmission and signal quality on level transmitters, including guided and unguided units.
            (a) Submit printout of the actual transmission and parameters.
        (2) Adjust mounting as required to obtain accurate readings.
        (3) Post mounting: Provide any additional calibration required by the manufacturer.
    c) Analog transmitters:
        (1) Components having adjustable features are to be set accurately for the specific conditions and applications of this installation.
        (2) Test and verify that components and/or systems are within the specified limits of accuracy.
        (3) Calibration points:
            (a) Calibrate each analog instrument at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span, using test instruments with accuracies traceable to NIST.
        (4) Field verify calibration of instruments, including units that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
    d) Analyzer:
        (1) Calibrate and test each analyzer system as a workable system after installation. Follow the testing procedures directed by the manufacturers' technical representatives.
        (2) Submit completed instrument calibration sheets for every field instrument and analyzer.
        (3) Calibration tags:
            (a) Attach a calibration and testing tag to each instrument, piece of equipment, or system.
            (b) Sign the tag when calibration is complete.
    e) Industrial networking test equipment:
        (1) Submit calibration documentation.

b. Loop check:
    1) Performed by the Contractor.
    2) Cabling installed, terminated, and labeled.
    3) Perform continuity check of wiring to each field device through intermediate devices to field terminals in the cabinet.
    4) Complete loop check form for each device.
    5) Submit loop check test results before proceeding to the next step.

c. Loop validation tests:
    1) Performed by the Contractor, ICSC, and the manufacturer's representative, working together, and witnessed by the Owner or Owner's representative.
    2) Perform tests on the signal from each field device through intermediate devices to the I/O module on the PLC.
        a) PLC may or may not be connected to the network.
    3) Engineer approval of the loop validation test Submittal is required before proceeding to CEET.
d. Copper Ethernet cable acceptance testing:
    1) Testing procedures and field-test instruments shall be in accordance with applicable requirements of:
        a) TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
        b) TIA-568.0-E - Generic Telecommunications Cabling for Customer Premises.
        c) TIA-568.1-E - Commercial Building Telecommunications Infrastructure Standard.
        d) TIA-568.2-D - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
        e) Copper Ethernet cable installation testing as specified in Section 26_08_50 - Field Electrical Acceptance Tests.
    2) Testing shall be performed by trained technicians who have successfully completed an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
        a) Manufacturer of the connectors or cable.
        b) Manufacturer of the test equipment used for the field certification.
        c) Training organizations (e.g., BICSI).
    3) Submit the following information before testing begins:
        a) Manufacturer's catalog sheets, specifications, and the most recent calibration report for the test equipment.
        b) Certificate of testing technician's training.
        c) A schedule of balanced twisted-pair copper links to be tested, including:
            (1) Cable identification as it appears on the cable records.
            (2) Cable identification as it appears on the individual test reports.
            (3) Cable identification as specified in Section 26_05_53 - Identification for Electrical Systems.
        d) Sample test reports.
        e) Installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described below:
            (1) Any Permanent Link that fails these requirements shall be diagnosed and corrected.
            (2) Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements.
            (3) Final and passing result of the tests for Permanent Links shall be provided in the test results documentation in accordance with the testing requirements.

f) Acceptance of the test results shall be given in writing after the Project is fully completed and tested in accordance with the Contract Documents and to the satisfaction of the Engineer.

4) Cable field-test instruments:
   a) Field-test instrument shall be within the calibration period recommended by the manufacturer, typically 12 months.
   b) Certification tester requirements:
      (1) Level III in accordance with TIA-1152.
      (2) Independent verification of accuracy.
      (3) Must be capable of storing more than 10,000 results for all required measurements.
      (4) Manufacturers: The following or equal:
         (a) Fluke CableAnalyzer Industrial Ethernet Kit, DSX2-5-IE-K1.
   c) Permanent Link adapters:
      (1) Use the manufacturer's adapter for connecting to tested equipment.
         (a) Patch cables shall not be used for testing.
      (2) RJ45 plug must meet the requirements for NEXT, FEXT, and return loss in accordance with TIA-568.2-D Annex C.
   d) Measurement capabilities:
      (1) Wire map.
      (2) Length.
      (3) Propagation delay.
      (4) Delay skew.
      (5) DC loop resistance.
      (6) DC resistance unbalance.
      (7) Insertion loss.
      (8) NEXT (near-end crosstalk).
      (9) PS NEXT (power sum near-end crosstalk).
      (10) ACR-N (attenuation to crosstalk ratio near-end).
      (11) PS ACR-N (power sum attenuation to crosstalk ratio near-end).
      (12) ACR-F (attenuation to crosstalk ratio far-end).
      (13) PS ACR-F (power sum attenuation to crosstalk ratio far-end).
      (14) Return loss.
      (15) TCL (transverse conversion loss).
      (16) ELTCTL (equal level transverse conversion transfer loss).
      (17) Time domain reflectometer.
      (18) Time domain crosstalk analyzer.

5) Testing requirements:
   a) Field-test instruments shall have the latest software and firmware installed.
   b) Permanent Link test results, including the individual frequency measurements from the tester shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.

c) Testing shall be performed on each cabling segment from connector to connector:
   (1) Sampling is not acceptable.
d) Installer shall build a reference link:
   (1) Components shall be anchored so it is not possible to disturb them.
   (2) Technician is to conduct a Permanent Link test each day, for each type of category cable used, to ensure no degradation of the tester or its Permanent Link adapters.
e) Unless noted otherwise tests shall use the following frequency resolution:
   (1) 1 to 31.25 MHz: 150 kHz.
   (2) 31.25 to 100 MHz: 250 kHz.
   (3) 100 to 250 MHz: 500 kHz.
f) Wire map measurement:
   (1) Wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors. For each of the 8 conductors in the cabling, the wire map indicates:
      (a) Continuity to the remote end.
      (b) Shorts between any 2 or more conductors.
      (c) Reversed pairs.
      (d) Split pairs.
      (e) Transposed pairs.
      (f) Distance to open on shield.
      (g) Any other miss-wiring.
      (h) Correct connectivity of telecommunications outlets/connectors is defined in TIA-568.2-D:
         - 2 color schemes are permitted.
         - User shall define which scheme is to be used.
         - Field tester shall document which color scheme was used.
g) Length measurement:
   (1) Record the length of each cable. Use the physical length of the link calculated using the pair with the shortest electrical delay for reporting and to determine pass/fail.
   (2) Pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in TIA-568.2-D plus the nominal velocity of propagation (NVP) uncertainty of 10 percent. For a Permanent Link, the length measurement can be 325 feet before a fail is reported.
h) Propagation delay measurement:
   (1) Is the time it takes for a signal to reach the end of the link.
   (2) Measurement shall be made at 10 MHz in accordance with TIA-1152.
   (3) Propagation delay of each balanced twisted pair shall be recorded.
   (4) Is not to exceed 498 ns in accordance with TIA-568.2-D Section 6.4.21.

i) Delay skew measurement:
   (1) Is the difference in propagation delay at 10 MHz between the shortest delay and the delays of the other wire pairs.
   (2) Delay skew of each balanced twisted pair shall be recorded.
   (3) Is not to exceed 44 ns in accordance with TIA-568.2-D Section 6.4.22.

j) DC resistance:
   (1) Often reported as resistance, is the loop resistance of both conductors in the pair.
   (2) Is not specified in TIA-1152 but shall be recorded for all 4 pairs.

k) DC resistance unbalance:
   (1) Often reported as resistance unbalance, is the difference in resistance of the 2 wires within the pair.
   (2) Is not specified in TIA-1152 for a Permanent Link but shall be recorded for all 4 pairs.

l) Insertion loss:
   (1) Is the loss of signal strength over the cabling (in dB).
   (2) Worst case shall be reported for all 4 pairs in one direction only.
   (3) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk.
   (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.10.

m) NEXT (near-end crosstalk):
   (1) Is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
   (2) Shall be measured in both directions (12 pair to pair possible combinations).
   (3) Both worst case and worst margins shall be reported.
   (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.11.
   (5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
   (6) Time domain crosstalk data shall be stored for any marginal or failing NEXT results.

n) PS NEXT (power sum near-end crosstalk):
   (1) Is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
   (2) Shall be measured in both directions (8 pair possible combinations).
   (3) Both worst case and worst margins shall be reported.
   (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.12.
   (5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
   (6) Time domain crosstalk data shall be stored for any marginal or failing PS NEXT results.

o) ACR-N (attenuation crosstalk ratio near-end):
   (1) Is a calculation of NEXT minus insertion loss of the disturbed pair in dB.
   (2) Shall be calculated in both directions.
   (3) Is not specified in TIA-1152 but shall be recorded for all 12 possible combinations.
p) PS ACR-N (power sum attenuation crosstalk ratio near-end):
   (1) Is a calculation of PS NEXT minus insertion loss of the disturbed pair in dB.
   (2) Shall be calculated in both directions.
   (3) Is not specified in TIA-1152 but shall be recorded for all 8 possible combinations.
q) ACR-F (attenuation crosstalk ratio far-end):
   (1) Is a calculation of FEXT minus insertion loss of the disturbed pair in dB.
   (2) Shall be measured in both directions (24 pair to pair possible combinations).
   (3) Both worst case and worst margins shall be reported.
   (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.14.
   (5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
r) PS ACR-F (power sum attenuation crosstalk ratio far-end):
   (1) Is a calculation of PS FEXT minus insertion loss of the disturbed pair in dB.
   (2) Shall be measured in both directions (8 pair possible combinations).
   (3) Both worst case and worst margins shall be reported.
   (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.16.
   (5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
s) Return loss:
   (1) Is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
   (2) Shall be measured in both directions (8 pair possible combinations).
   (3) Both worst case and worst margins shall be reported.
   (4) Shall be ignored at all frequencies where the insertion loss is less than 3 dB for that pair.
   (5) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.9.
   (6) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
   (7) Time domain reflectometer data shall be stored for any marginal or failing return loss results.
t) TCL (transverse conversion loss):
   (1) Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.

(2) Shall be measured in both directions.
(3) Is not specified in TIA-1152 for a Permanent Link but shall be recorded for all 8 possible combinations.

u) ELTCTL (equal level transverse conversion transfer loss):
(1) Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the insertion loss of that pair.
(2) Shall be measured in both directions.
(3) Is not specified in TIA-1152 for a Permanent Link but shall be recorded for all 8 possible combinations.

6) Test results documentation:
a) Detailed test results documentation data is to be provided in an electronic database for each tested balance twisted pair and shall contain the following information:
(1) Overall pass/fail evaluation of the link-under-test.
(2) Date and time the test results were saved in the memory of the tester.
(3) Identification of the customer site as specified by the end user.
(4) Name of the test limit selected to execute the stored test results.
(5) Name of the personnel performing the test.
(6) Version of the test software and the version of the test limit database held within the test instrument.
(7) Manufacturer, model, and serial number of the field-test instrument.
(8) Adapters used.
(9) Factory calibration date.
(10) Wire map.
(11) Propagation delay values, for all 4 pairs.
(12) Delay skew values, for all 4 pairs.
(13) DC resistance values, for all 4 pairs.
(14) DC resistance unbalance, values for all 4 pairs.
(15) Insertion loss, worst case values for all 4 pairs.
(16) NEXT, worst case margin and worst case values, both directions.
(17) PS NEXT, worst case margin and worst case values, both directions.
(18) ACR-F, worst case margin and worst case values, both directions.
(19) PS ACR-F, worst case margin and worst case values, both directions.
(20) Return loss, worst case margin and worst case values, both directions.
(21) TCL, worst case values both directions.
(22) ELTCTL, worst case values, both directions.
(23) Time domain crosstalk data if the link is marginal or fails.
(24) Time domain reflectometer data if the link is marginal or fails.

b) Maintain a set of “red-line” throughout during construction:
(1) Drawings shall be available for review at any time as requested by the Owner or Engineer.
(2) Provide record copy drawings at the end of the Project.
(a) Shall be in CAD format and include notations reflecting the as-built conditions of any additions to or variation from the drawings provided, such as, but not limited to, cable paths and termination point.
(3) As-built drawings shall include, but are not limited to, block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details.
(4) As-builts shall include field changes made up to construction completion:
(a) Field directed changes to pull schedule.
(b) Horizontal cable routing changes.

7) Associated detail drawings. Engineer approval of the copper Ethernet cable acceptance-testing Submittal is required before proceeding to CEET.

e. Complete End-to-End Testing (CEET):
1) Performed by the Contractor, ICSC, and the manufacturer’s representative working together, with assistance from the Owner or the inspection staff, as needed:
a) Participants need to be dedicated full-time to CEET.
b) ICSC will provide staff to verify input signals at, and create output signals from, an HMI or engineering workstation.
c) Contractor and ICSC will be responsible for creating field signals and verifying proper operation of final control elements.
2) Prerequisites:
a) CEET cannot begin until the successful completion of the preceding tests:
(1) Calibration.
(2) Loop check.
(3) Loop validation tests.
(4) Copper Ethernet cable acceptance testing.
(5) Industrial network testing.
3) Testing description:
a) This testing is to ensure I/O signals operate to the intent of the design from the field device to the HMI and all other auxiliary controls and indicators in the PCS.
b) Connect PLC to the network to test signals from the field device through the PLC program, the network, and to the operator’s HMI graphic screens. Outputs will be energized for a duration long enough to verify proper operation of the final control element.
c) SCADA screens:
(1) Test and record operator commands and signal readouts to each operator device where there is more than one operator interface point.
(2) For each signal, perform separate tests for SCADA computer screens, local operator interface (LOI) screens, and local control panels.
(3) Retest any loop following any necessary corrections.

4) Check control loops under simulated operating conditions by causing a range of input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the HMI/SCADA system:
    a) Use actual process inputs wherever available.
    b) Issue commands from the HMI/SCADA system and verify proper responses of field devices:
        (1) Test SCADA system inputs from field device to SCADA system operator workstations:
            (a) Track responses through trend charts in the HMI/SCADA system.
        (2) Test SCADA system outputs from SCADA operator workstations to field devices and equipment.
5) Discrete device testing:
    a) Exercise each field device providing a discrete input to the HMI/SCADA system in the field and observe the proper operation shall be observed at the operator workstation:
        (1) Test limit switches, set limits mechanically, and observe proper operation at the operator workstation.
        (2) Exercise starters, relay contacts, switch contacts, and observe proper operation.
        (3) Calibrate and test instruments supplying discrete inputs and observe proper operation.
    b) Test each device accepting a discrete output signal from the HMI/SCADA. Perform the appropriate operator action at the SCADA operator stations (including LOIs, if present) and confirm the proper operation of the field device:
        (1) Stroke valves through outputs from the HMI/SCADA system and confirm proper directional operation. Confirm travel limits and any feedback signals to the HMI/SCADA system.
        (2) Exercise motors starters from the HMI/SCADA system and verify proper operation through direct field observation.
        (3) Exercise solenoids and other field devices from the HMI/SCADA system and verify proper operation through direct field observation.
6) Analog device testing:
    a) Apply continuously variable up and down analog inputs to verify the proper operation and setting of discrete devices (signal trips, etc.).
    b) Apply provisional settings on controllers and alarm setpoints.
7) Analog input:
    a) Exercise each field device monitoring the analog signal, through the HMI/SCADA system:
        (1) Apply simulated sensor inputs corresponding to 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span for networks that incorporate analog elements and monitor the resulting outputs to verify compliance to accuracy tolerance requirements.

8) Analog output:
    a) Exercise each field device requiring an analog command signal, through the HMI/SCADA system:
        (1) Vary the output from the PLC HMI/SCADA system and measure the end device position, speed, etc., to confirm the proper operation of the device for the supplied analog signal.
        (2) Manually set the output from the HMI/SCADA screen at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent and measure the response at the final device and at any intermediate devices.
9) Submit completed test forms:
    a) Discrete instrument input devices:
        (1) Switch setting, contact action, and dead band.
        (2) Valve position switches:
            (a) Response in the PLC as the valve is stroked from the PLC.
            (b) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
        (3) Operator interface switches (control stations and other pilot devices) and associated response.
        (4) Starter and drive auxiliary device contact response.
        (5) Response of all other discrete inputs to the PLC.
        (6) Test equipment used and associated serial numbers.
    b) Discrete output devices:
        (1) Observed response of field device to the discrete output from the PLC.
        (2) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
        (3) Test equipment used and associated serial numbers.
    c) Analog input devices:
        (1) Calibration range.
        (2) Calibration data: Input, output, and error at each test value.
        (3) Analog input associated PLC register address.
        (4) Value in PLC register at each test point.
        (5) Value displayed at each operator interface station (local operator interface displays and SCADA workstations).
        (6) Test equipment used and associated serial numbers.
    d) Analog output devices:
        (1) Calibration range.
        (2) Test value at each test point.
        (3) Analog output associated PLC register address.
        (4) Control variable value at field device at each test point.
        (5) Physical device response at each test point:
            (a) Response to be actual valve position, or motor speed, etc.
        (6) Test equipment used and associated serial numbers.
10) Failure testing:
    a) Demonstrate how the system reacts and recovers from abnormal conditions, including, but not limited to:
        (1) Equipment failure.

(2) Communications sub-system error.
(3) Power failure.
(4) Process equipment failure.
(5) High system loading conditions.

11) Engineer approval of the CEET Submittals is required before proceeding to Functional Testing.

5. Functional Testing:
   a. General:
      1) Testing to demonstrate proper operation of systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
      2) Performed by the Contractor, ICSC, and the manufacturer's representative working together, with assistance from the Owner or the inspection staff, as needed.
      3) Additional tests are specified in other instrumentation and control Sections.
      4) Follow approved detailed test procedures and check lists for Functional test activities.
   b. Control logic operational validation:
      1) The purpose of control logic validation is to field test the operation of the complete control system, including all parts of the HMI/SCADA system, control panels (including vendor control panels), control circuits, control stations, monitored/controlled equipment, and final control elements.
      2) Demonstrate control functionality shown on the P&IDs, control schematics, and other drawings, and specified in the loop descriptions, control strategies, electrical Specifications, and mechanical equipment Specifications.
      3) Test in detail on a function-by-function and sentence-by-sentence basis.
      4) Thoroughly test hardware and software functions, including hardwired and software control circuit interlocks and alarms.
      5) Test final control elements, controlled equipment, control panels, and ancillary equipment under startup, shut down, and steady-state operating conditions to verify logic and control is achieved.
      6) Control logic validation tests to include, but not be limited to, a repeat of control logic tests from the FAT, modified and expanded to include field instruments, control panels, circuits, and equipment.
   c. Loop tuning:
      1) Optimally tune electronic control stations and software control logic incorporating proportional, integral, or derivative control. Apply control signal disturbances at various process variable levels and adjusting the gain, reset, or rate settings as required to achieve proper response.
      2) Verify the transient stability of final control elements operating over the full range of operating conditions, by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations and making necessary controller adjustments

as required to eliminate excessive oscillatory amplitudes and decay rates.
a) As a minimum, achieve 1/4-wave amplitude decay ratio damping (subsidence ratio of 4) under the full range of operating conditions.

3) If excessive oscillations or system instability occur, as determined by the Engineer, continue tuning and parameter adjustments, or develop and implement any additional control algorithms needed to achieve satisfactory control loop operation.

4) Functional validation sheets:
a) Document each Functional test on an approved test form.
b) Document loop tuning with a report for each loop, including 2-pen chart recordings showing the responses to step disturbance at a minimum of 3 setpoints or process rates approved by the Engineer. Show tuning parameters on the charts, along with time, date, and sign-off by the Contractor and Engineer.
c) Include on the form, functions which can be demonstrated on a loop-by-loop basis:
(1) Loop number and P&ID number.
(2) Control strategy, or reference to specification tested.
(3) Test procedures: Where applicable, use the FAT function-by-function, sentence-by-sentence loop test checklist forms modified to meet the requirements of the Functional test. Otherwise, create new forms.
d) For functions that cannot be demonstrated on a loop-by-loop basis (such as overall plant power failure), include on the test form a listing of the specific steps and tests to be conducted. Include with each test description the following information:
(1) Specification page and paragraph of function demonstrated.
(2) Description of function and/or text from specification.
(3) Test procedures: Use the FAT loop test checklist forms modified to meet the specific testing conditions of the Functional test.

5) Functional certification:
a) Including test forms with test data entered, submitted to the Engineer with a clear and unequivocal statement that Functional test requirements have been satisfied.

C. Process Start-up Phase:
1. Process Start-up:
a. ICSC shall be on site to support process Start-up activities and provide functional changes as required.
2. Process operation period:
a. ICSC shall be available to support process operational period and provide functional changes as required.
3. PCIS optimization and fine-tuning:
a. General:
1) After the process operational period, test PCIS system for additional 60 days as specified in this Section to identify issues and make corrections, as needed.

2) This is part of the Work that must be completed as a condition of Substantial Completion and final completion for the entire Project.
3) Complete PLC control and HMI/SCADA system must run continuously for the duration of the PCIS optimization and fine-tuning.
4) Test and use the entire process control system under standard operating conditions.
5) Exercise system functions.
6) Log failure, any system interruption and accompanying component, subsystem, or program failure, including time of occurrence, duration of each failure, failure classification, and cause:
    a) Provide a competently trained technician or programmer on call for the Project Site during normal working days and hours from the start of the PCIS optimization and fine-tuning until final acceptance of the system:
        (1) Response time to the Project Site: 24 hours or less, for a major failure.

b. SCADA system testing:
1) Exercise each system function, e.g., status report, alarms, logs, and displays several times at a minimum, and in a manner that approximates “normal” system operation.
2) Failure of the HMI/SCADA system during testing shall be considered as indicating that the programs and operating system do not meet the requirements of the specifications:
    a) Corrective action is required before restarting the PCIS optimization and fine-tuning.
3) Only those components, sub-systems, and systems covered in this Section and supplied under this Contract shall be considered for this acceptance test. Problems and failures of other systems shall not be considered as part of this test, except as they display the capabilities of this system to detect failures.
4) Failures:
    a) Classify failures as either major or minor:
        (1) Minor failure:
            (a) A small and non-critical component failure or software problem that can be corrected by the Owner’s operators.
            (b) Log this occurrence but this is not a reason for stopping the test and is not grounds for non-acceptance.
            (c) Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance.
            (d) Failure of 1 printer or operator station is considered a minor failure providing all functions can be provided by backup equipment, i.e., alternate printers and operator station, and repairs can be made, and equipment returned to service within 3 working days.
        (2) Major failure:
            (a) Considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or

when a technician's work is required to make a repair or to re-initiate operation of the system.

(b) Cause termination of the PCIS optimization and fine-tuning.

(c) Start a new acceptance test when the causes of a major failure have been corrected.

(d) A failure is also considered major when failure of any control system that results in an overflow, underflow, overdose, or underdose condition occurs.

5) Technician report:

a) Each time a technician is required to respond to a system malfunction, they must complete a report, which includes details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.

b) If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report is required or logged as specified above.

c) If a technician has performed work but no report is written, then a major failure is considered to have occurred.

d) Each report shall be submitted within 24 hours to the Engineer and the Owner, or its representative.

3.03 SCHEDULES

A. Example test forms:

1. Attached at the end of this Section. They may be used as a starting point for the development of project-specific test forms for this Project.
2. Not intended to be complete or comprehensive. Edit and supplement the forms to meet the requirements for testing and test forms specified in this Section and other Contract Documents.

END OF SECTION

ATTACHMENT A - FACTORY ACCEPTANCE TEST - CONTROL PANELS

	FACTORY ACCEPTANCE TEST - CONTROL PANELS	

1. GENERAL INSPECTION

A. Structural Inspection

- ☐ Verify lifting lugs installed.
- ☐ Verity enclosure has lock and lock is functional.
- ☐ Confirm that seismic bracing components are provided in accordance with manufacturer's installation instructions.

B. Exterior Inspection

- ☐ Cabinet exterior is clean, scratch, and dent free.
- ☐ Inspect externally for corrosion and damage.
- ☐ Verify enclosure door opens and closes easily.
- ☐ Verify enclosure has a 3-point latch.
- ☐ Verify enclosure has a flange mounted disconnect (where voltages greater than 120 VAC enter the cabinet).
- ☐ Verify enclosure has the appropriate NEMA rating (1, 1G, 12, 3R, 4, 4X, etc.).
- ☐ Verify enclosure is the appropriate size (not grossly larger than design, and will still fit in the plant).

Nameplates

- ☐ Cabinet has identification nameplate.
- ☐ All door labels are straight, spelled correctly, and match the tagging defined in the Contract.
- ☐ Cabinet has a nameplate that includes the following:
  - ☐ Power source(s).
  - ☐ Integrator's logo.
  - ☐ Circuit ID(s).
  - ☐ Short Circuit KAIC ratings.
- ☐ If labels are screwed to door, silicone was utilized to cover screw holes. (Labels screwed to the door of a NEMA 4/4X panel technically violates the NEMA rating.)

Door Devices

- ☐ All devices penetrating the outside of panel have gaskets, silicone or both.
- ☐ All door devices are installed (HMIs, Pilot Devices, etc.).
- ☐ Door mounted equipment is mounted straight and square.
- ☐ All exterior or door mounted equipment present and accounted for, installed and securely fastened.
- ☐ NEMA classification has not been violated due to penetrations.
- ☐ Door mounted equipment has the same NEMA rating as the panel.
- ☐ All door mounted equipment installed at the correct height.
- ☐ All door mounted equipment installed in the correct positions and order (layout of door mounted equipment is grouped properly and in a logical manner).
- ☐ Doors with multiple penetrations have adequate bracing (if needed).
- ☐ Visually check condition of indicators, controllers, and annunciators.
- ☐ Check that pilot lights illuminate correctly.
- ☐ Check the Push-To-Test function.
- ☐ Ensure correct pilot light color.

Peripheral Devices

- ☐ Horn/Beacon is installed (where required).
- ☐ Silence and Reset pushbutton.

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	FACTORY ACCEPTANCE TEST - CONTROL PANELS	

1. GENERAL INSPECTION (continued)

C. Interior Inspection

- ☐ Cabinet is cleaned of marks and dirt.
- ☐ Inspect internally for corrosion and damage.
- ☐ Back panel is clean of marks and dirt.
- ☐ Interior of panel vacuumed and shall be free of all debris.
- ☐ Check that the panel roof is clean and clear of foreign materials.
- ☐ Bottom of panel has been cut out (where bottom entry is required), with angle iron welded around the bottom perimeter. Re-painting has been performed.
- ☐ If internal light door limit switch is provided, ensure the light automatically turns “on” when the doors are open.
- ☐ Check that a document pocket has been provided.
- ☐ Intrusion alarms (where required).

Interior Labeling

- ☐ All panel mounted equipment has identification labeling, by using either a Brothers or Phenolic type tags.
- ☐ Verify that door mounted components are mounted square and symmetrical.
- ☐ Verify that nameplates are straight, legible, and spelled correctly.
- ☐ All terminal blocks are identified/labeled with permanent labels, including tight end blocks and caps.
- ☐ All wiring shrink labeled and or phased correctly to the specifications.
- ☐ All wire labels shrunk completely rotated and aligned alike for easy identification.
- ☐ All fuses and circuit breakers are labeled with ID and current rating.
- ☐ System Integrator’s label or labels installed on door.
- ☐ Panel manufacturer model/serial number tag is present.
- ☐ All required safety/warning tags installed and straight.
- ☐ Correct UL (typically UL 508) or cUL tag installed and registered and all other associated tags installed and straight. (The UL tag might not be installed in the panel at the factory test. If the panel is modified due to changes during the factory test or a punch list generated from the factory test, the UL labeling would need to be re-applied. Some UL shops do not apply the UL label until the panel is released to be shipped.)

Wireways

- ☐ Plastic wire way covers installed properly.
- ☐ Plastic wireways have no sharp edges.
- ☐ No wire ties inside the wireways.
- ☐ No sharp edges on wire ties.
- ☐ Separation: White duct is used for DC voltages; Gray duct is used for AC voltages.
- ☐ Ensure wiring duct is not over-full, includes provision for 20% more wiring and the cover may easily be installed. Panduit recommends 50% duct fill, but 40% is a better practice.

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1. GENERAL INSPECTION (continued)

C. Interior Inspection (continued)

Wiring

- ☐ Visually check terminals and condition of internal wirings.
- ☐ Verify that the control panel has been assembled and wired as designed.
- ☐ Verify that all components are operational and perform the functions intended.
- ☐ Verify that all components are sized appropriately for the application.
- ☐ Verify that equipment control circuits function as intended.
- ☐ Back of door wiring is labeled and neatly formed.
- ☐ Back panel to door wiring has sufficient bending radius with spiral wrap.
- ☐ Wire connection has been verified wired to correct points within the panel.
- ☐ Individual wires have been given a pull test to verify a good terminal connection.
- ☐ Wire and cable minimum bending radius have not been violated.
- ☐ All equipment installed straight and square to back panel.
- ☐ Wire colors are correct:
  - ☐ Black and White > AC hot and neutral, respectively.
  - ☐ Red > AC control signals.
  - ☐ Blue > DC power and control.
  - ☐ White w/Blue stripes > DC ground.
  - ☐ Yellow > Foreign voltages (those still present when panel power is disconnected).
  - ☐ Green > AC equipment ground.
  - ☐ Black > TSP (+).
  - ☐ White > TSP(-).
- ☐ Analog wiring shields are continuous (connected by a dedicated terminal block for such shields).
- ☐ Analog shield wires are grounded within the panel, where not otherwise grounded at the transmitter itself.
- ☐ Discrete inputs are separately fused or protected by a circuit breaker on a “per loop” basis.
- ☐ Intrinsic Safety Wiring.
  - ☐ Ensure wiring associated with intrinsic safety circuits or intrinsic safety barriers is kept away from all other wiring by UL minimum distances or by a physical (grounded metal) barrier preventing non-intrinsically safe wiring from coming in contact with intrinsically safe circuits or wiring.
- ☐ Verify all spare terminals are installed according to the percentage listed in the specifications.

Grounding

- ☐ Equipped with “Blackburn” or other grounding type lug.
- ☐ Lug is securely fastened to the panel structure.
- ☐ Verify grounding bar is installed.
- ☐ Verify isolated ground bar is installed.

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	FACTORY ACCEPTANCE TEST - CONTROL PANELS	

2. POWER TEST

A. AC Power

- ☐ AC power is routed correctly within the panel and is isolated from DC and network wiring.
- ☐ All fuses are installed and sized properly.
- ☐ All breakers are installed and sized properly.
- ☐ 24 VDC Power Supplies are functional.
- ☐ 24 VDC Power fail contacts are functional.
- ☐ 24 VDC power supplies are redundant and have diode modules enabling the hot swap-over between supplies.
  - ☐ 24 VDC supplies are equipped with dry contact failure alarms, wired as PLC inputs to signal failure of any DC power supply. Such alarm inputs to the PLC have been tested as being functional.
- ☐ Dedicated receptacle is wired to receive a dedicated AC supply.
- ☐ Verify continuity for all DC commons, ground and AC neutrals.
- ☐ Verify that the CP temporary input power is connected correctly and is the correct voltage.
- ☐ Close the CP main circuit breaker(s).
- ☐ Verify that voltages at subsequent circuit breakers are correct.
- ☐ Close circuit breakers.
- ☐ Verify that power feeding interruptible and uninterruptible power supplies is correct.
- ☐ Turn on power supplies if they are not already on.
- ☐ Verify that voltages at distribution terminals are correct.
- ☐ Energize any remaining hardware such as the PLC.

B. Uninterruptible Power Supply (UPS)

- ☐ Mounted appropriately within the cabinet, on a dedicated shelf, or rear of a swing-out sub panel.
- ☐ Is equipped with maintenance bypass switch (or at least plug/receptacle means for bypassing the unit).
- ☐ Test all UPS alarms (on inverter, failure, battery failure etc.).
- ☐ Turn off the AC power supply and verify that the UPS will be switched on to supply the designated vital loads in the control panel.

3. CONTROLS & AUXILIARY DEVICES TEST

- ☐ Verify all interposing and auxiliary relays are functioning.
- ☐ Verify panel lights are functioning.

Ventilation and Heating

- ☐ If ventilation fans are fitted, check the fans operate correctly any associated air filters are clean and not blocked.
- ☐ Verify components are installed in the correct orientation for proper air flow.

4. HARDWIRED INTERLOCK AND SAFETY TEST

- ☐ Verify that hardwired interlocks through the control panel as shown on schematic drawings are functioning. For example, outlet high pressure switch interlock to a pump.
- ☐ Verify that all hardwired safety devices through the control panel is functioning. For example, the pull cord emergency stops of conveyors.

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5. PLC TEST

A. Components

☐ PLC interior High Temperature alarm is installed, wired to the PLC, and is shown to be functional.

☐ Relays have transient suppression across their coils. This is particularly important for DC coil relays, where diodes in reverse polarity are often used.

☐ TVSS is installed across the main incoming 120 VAC.

PLC and PLC Rack

☐ Verify all cards are securely seated.

☐ Ensure clearance around PLC rack has been met, such that convective heat transfer is not impeded by devices erroneously mounted in the “no encroachment” area. Confirm with manufacturer clearance recommendations.

B. PLC I/O Test

☐ Furnish **I/O test forms** and test all the listed input and output points as follows:

☐ Discrete Inputs: Simulate a field contact closure by “shorting” across the appropriate terminal blocks. Observe the transition between a logical “0” and “1” in the PLC software.

☐ Discrete Outputs: Force the output bit to toggle between logical “0” and logical “1” using the PLC software. Measure contact resistance at the wired terminal blocks using a digital meter selected for the “ohms” setting.

☐ Analog Inputs: Connect a signal generator to the appropriate terminal blocks. Tailor the connection depending on whether a 2-wire or 4-wire simulation is required. Modulate the 4-20mA signal. Observe the associated PLC internal memory register to transition between 0-65535 or if scaled in engineering units, between 0 and the maximum scaled engineering unit. The latter method is preferred.

☐ Analog Outputs: Force the output register to a value between 0-65535 or 0-100%, if the scaling block can be manipulated. Observe the measured 4-20mA value increment and decrement using a digital ammeter.

C. Redundant Controllers (where required) Test

☐ Remove Communication cable from primary PLC to verify switching to backup PLC.

☐ Remove Communication cable from backup PLC to verify switching back to primary PLC.

☐ Remove Power cable from primary PLC to verify switching to backup PLC.

☐ Remove Power cable from backup PLC to verify switching back to primary PLC.

D. PLC Control Logic Verification

☐ The PLC control strategy is verified by following the Control Logic Verification Form based on the specifications. Each control strategy will be verified by simulating the process and checking the state or value of PLC outputs. The results of equipment status and alarms and process instrument values and trends shall also be verified on the Plant SCADA graphic screens stored in a temporary SCADA computer. Since all PLC input and output wiring has been verified and some field devices are not available during Factory Acceptance Testing, certain inputs will be simulated either by means of additional hardware and/or software as described below.

☐

☐

☐ DI states are either simulated by hardwired switches or forced inputs using a programming terminal.

☐ For example, when starters and drives are not provided as part of the Contract, jumpers may be installed from the output call relays to the running confirmation inputs to simulate the running state of the motors.

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5. PLC TEST (continued)

D. PLC Control Logic Verification (continued)

Typical Fault Logic

- ☐ If the fault input is high and the disable (if applicable) for the fault is not high and the common disable (if applicable) is not high begin timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output. If the fault alarm is a shutdown alarm stop the associated motor and latch the alarm so that it remains present even if the condition clears.
- ☐ The fault condition must return to normal and the alarm must be reset for a latched alarm to clear.

Typical Fail to Start Logic

- ☐ If the motor is called to run (call output high) and no running feedback is received (running input is low) and the fail to start and common alarm disables (if applicable) are not high start timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output, stop calling the motor and latch the alarm.

6. HMI OR OIT TEST

HMI/OIT Functionality

- ☐ Communication with PLC.
- ☐ Screen Layouts.
- ☐ Screen Navigation.
- ☐ Set Point Entry.
- ☐ Animation.
- ☐ Color Correctness (Green=Run, Red=Off, Amber=Alarm, or the agreed upon convention).
- ☐ Alarms.
- ☐ Acknowledge and Reset.
- ☐ Security/Access Levels/Passwords.

7. NETWORK COMMUNICATION TEST

A. Network Components

- ☐ Fiber optic cabling terminates in a patch panel.
- ☐ Media converters are installed and functional.
- ☐ Terminating resistors have been installed for trunk/tap topologies or where required.
- ☐ Wire and cable bending limitations have not been violated.

B. Networking Functions

- ☐ Verify data transfer via the network to different PLCs as shown on the Network Block Diagrams.
- ☐ Verify network traffic rate and error margin is acceptable.

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	FACTORY ACCEPTANCE TEST - CONTROL PANELS	

8. FAT DOCUMENTATION AND RECORD

Panel Documentation

- ☐ As-built panel drawings showing actual panel construction and devices arrangement and c/w Bill of Material.
- ☐ Panel schematic and interconnection drawings.
- ☐ P&ID drawings and schematic drawings for the process area controlled by the panel that is to be tested.
- ☐ I/O list test forms of the process area to be tested.
- ☐ FAT procedure of the process area to be tested.
- ☐ Test record forms of the process area to be tested. Forms shall include area for signature of responsible test personnel.
- ☐ Hard copy of the PLC application program of the process area to be tested.
- ☐ Hard copy of the HMI/OIT graphic screens of the process area to be tested.

9. FAT TOOLS AND SOFTWARE

- ☐ Simulation software if required.
- ☐ Digital volt meter Fluke 87.
- ☐ Process meter Fluke 787.
- ☐ Laptop computer with PLC application program.
- ☐ Temporary SCADA computer with HMI software and applicable graphic screens.
- ☐ Jumper wires.

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ATTACHMENT B - INSTALLATION AND CERTIFICATION CHECKLIST DOCUMENTATION

	INSTALLATION AND CERTIFICATION CHECKLIST DOCUMENTATION	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

A COPY OF LATEST ISSUE OF THE FOLLOWING DOCUMENTS ARE INCLUDED IN THIS INSTRUMENT INSTALLATION CERTIFICATION FILE:

☐ INSTRUMENT SPECIFICATION SHEETS (FOR ALL INSTRUMENTS IN THE LOOP)

☐ INSTRUMENT INSTALLATION DETAILS (FOR ALL INSTRUMENTS IN THE LOOP)

☐ INSTRUMENT LOOP WIRING DIAGRAMS

☐ INSTRUMENT INSTALLATION CERTIFICATION CHECKLIST

☐ SIZING CALCULATIONS

☐ INSTRUMENT INSTALLATION SCHEDULE (APPLICABLE PART)

☐ NAMEPLATE SCHEDULE (APPLICABLE PART)

☐ VENDOR LITERATURE CALIBRATION INFORMATION

	☐ No	☐ Yes
INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?		

REMARKS: _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT C - SWITCHES INSTALLATION AND CALIBRATION CHECKLIST

	SWITCHES INSTALLATION AND CALIBRATION CHECKLIST	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, WHEN COMPLETED:

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

	☐ No	☐ Yes
INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?		

FIELD CALIBRATION CHECK

CONTACT NO.	FUNCTION	FOR SIGNAL	CONTACT IS TO	AT SPECIFIED VALUE FOR		ACTUAL TRIP POINT WAS	
1	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
2	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
3	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
4	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	

NOTE: PERM IS ABBREVIATION FOR PERMISSIVE

	SWITCHES INSTALLATION AND CALIBRATION CHECKLIST	

REMARKS: _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT D - TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ No ☐ Yes

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?

INSTRUMENT TYPE ☐ TRANSMITTER ☐ CONTROLLER ☐ INDICATOR

☐ OTHER DESCRIPTION _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

BENCH CALIBRATION CHECK

INPUT RANGE = _____ OUTPUT RANGE = _____

HEAD CORRECTION = _____ ☐ LINEAR

CALIBRATED SPAN = _____ ☐ SQUARE ROOT

% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

CHECK BELOW, WHEN COMPLETED:

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

FIELD CALIBRATION CHECK

INPUT RANGE = _____ OUTPUT RANGE = _____

% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ DIRECT ☐ REVERSE

☐ ACTION VERIFIED AT 50% SPAN

☐ ACTION VERIFIED AT _____ SPAN

CONTROLLER SETTINGS								
SETTING	GAIN	PB	RESET (INTEGRAL)	DERIV. (RATE)	HIGH LIMIT	LOW LIMIT	ELEV. ZERO	ZERO SUPP
PRE-TUNE								
POST-TUNE								

PRE-TUNE SETTINGS					
	GAIN	PB	RESET (REPEAT/MIN)	RESET (MIN/REPEAT)	DERIVATION (MINUTES)
FLOW	1.0	100	10	0.1	N/A
LEVEL	1.0	100	MIN.	MAX.	N/A
PRESSURE	2.0	50	2.0	0.5	N/A
TEMP.	4.0	25	0.1	10	OFF

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT E - ANALYZERS INSTALLATION AND CALIBRATION CHECKLIST

	ANALYZERS **INSTALLATION AND CALIBRATION CHECKLIST**	

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS? ☐ No ☐ Yes

TYPE OF INSTRUMENT _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, IF TRUE

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT F - CONTROL VALVES
INSTALLATION AND CALIBRATION CHECKLIST

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ No ☐ Yes

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?

☐ VALVE TAG NO. _____ SERIAL NO. _____

☐ TRANSDUCER TAG NO. _____ SERIAL NO. _____

☐ SOLENOID TAG NO. _____ SERIAL NO. _____

☐ VOLUME BOOSTER TAG NO. _____ SERIAL NO. _____

☐ POSITIONER _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

TRANSDUCER CHECK					
INPUT RANGE =			OUTPUT RANGE =		
CALIBRATED SPAN =			CALIBRATED SPAN =		
BENCH					
SPAN	**DESIRED**	**ACTUAL**	**SPAN**	**EXPECTED**	**ACTUAL**
0%			0%		
50%			50%		
100%			100%		
FIELD					
SPAN	**DESIRED**	**ACTUAL**	**SPAN**	**EXPECTED**	**ACTUAL**
0%			0%		
50%			50%		
100%			100%		

CHECK BELOW, IF TRUE:

☐ BENCH CALIBRATED PER ABOVE _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

- ☐ VALVE SPECIFICATION NO. _____
- ☐ TRANSDUCER SPECIFICATION NO. _____
- ☐ SOLENOID SPECIFICATION NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER INSTRUMENT INSTALLATION DETAILS _____

- ☐ VALVE DETAIL NO. _____
- ☐ TRANSDUCER DETAIL NO. _____
- ☐ SOLENOID DETAIL NO. _____

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

VALVE CHECK			
FLOW CHECK	☐ PROCESS FLOW DIRECTION THROUGH THE VALVE IS CORRECT		
SAFETY CHECK	ON LOSS OF AIR VALVE FAILS ☐ OPEN ☐ CLOSE	ON LOSS OF POWER SOLENOID FAILS ☐ TO VENT ☐ TO VALVE	
TRAVEL CHECK	FULL OPEN AT _____ PSI	FULL CLOSED AT _____ PSI	MEASURED TRAVEL _____ INCHES
SEATING CHECK	☐ ON BENCH ☐ IN-LINE	RESULTS	ACTUATOR BENCH SET
POSITIONER CHECK			
VALVE FULL OPEN AT _____ PSI TO POSITIONER _____			
VALVE FULL CLOSED AT _____ PSI TO POSITIONER _____			
VOLUME BOOSTER CHECK			
BYPASS VALVE (GAIN) ADJUSTING SCREW BACKED OUT _____ TURNS FROM CLOSED TO ENSURE QUICK BUT STABLE OPERATION (TYPICALLY 1-1/2 TO 2 TURNS)			

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

SECTION 40_96_15

SCHEDULES: I/O LIST

PART 1 GENERAL

1.01 SUMMARY

A. The I/O List is not a take-off list.
   1. Additional information is as indicated on the Drawings and specified in the Contract Documents.
   2. Where any discrepancies between this list and the P&ID drawings arise, the P&ID shall govern.

B. Abbreviations used in the I/O List are indicated on the Drawings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 I/O LIST

A. As specified in Attachment A - I/O List.

END OF SECTION

ATTACHMENT A - I/O LIST

PLC I/O Listing for PLC-2

Drawing	Tag	I/O	Location	Description	Service	(E/F)
050N102	SPDF-34033	AI	PLC-2	SPEED FBK	WAS PUMP 1	
050N102	SPDF-34034	AI	PLC-2	SPEED FBK	WAS PUMP 2	
PLC-2	**Total AI Points = 2**					
050N102	SPDC-34033	AO	PLC-2	SPEED CMD	WAS PUMP 1	
050N102	SPDC-34034	AO	PLC-2	SPEED CMD	WAS PUMP 2	
PLC-2	**Total AO Points = 2**					

PLC I/O Listing for PLC-2

Drawing	Tag	I/O	Location	Description	Service	(E/F)
050N102	FAIL-34033	DI	PLC-2	FAILED	WAS PUMP 1	
050N102	FAIL-34034	DI	PLC-2	FAILED	WAS PUMP 2	
050N102	PSH-34033	DI	PLC-2		PRESSURE SWITCH HIGH	
050N102	PSH-34034	DI	PLC-2		PRESSURE SWITCH HIGH	
050N102	REM-34033	DI	PLC-2	REMOTE	ELECTRIC DISCRETE VALVE OPEN/CLOSE	
050N102	REM-34033	DI	PLC-2	REMOTE	WAS PUMP 1	
050N102	REM-34034	DI	PLC-2	REMOTE	ELECTRIC DISCRETE VALVE OPEN/CLOSE	
050N102	REM-34034	DI	PLC-2	REMOTE	WAS PUMP 2	
050N102	RNG-34033	DI	PLC-2	RUNNING	WAS PUMP 1	
050N102	RNG-34034	DI	PLC-2	RUNNING	WAS PUMP 2	
050N102	TSH-34033	DI	PLC-2	HI TEMP	WAS PUMP 1	
050N102	TSH-34034	DI	PLC-2	HI TEMP	WAS PUMP 2	
050N102	ZSC-34033	DI	PLC-2	CLOSED	ELECTRIC DISCRETE VALVE OPEN/CLOSE	
050N102	ZSC-34034	DI	PLC-2	CLOSED	ELECTRIC DISCRETE VALVE OPEN/CLOSE	
050N102	ZSO-34033	DI	PLC-2	OPENED	ELECTRIC DISCRETE VALVE OPEN/CLOSE	
050N102	ZSO-34034	DI	PLC-2	OPENED	ELECTRIC DISCRETE VALVE OPEN/CLOSE	
340N101	FSL-33088	DI	PLC-2		THERMAL FLOW SWITCH	
340N101	PSL-33088	DI	PLC-2		PRESSURE SWITCH LOW	
340N101	REM-33088	DI	PLC-2	REMOTE	SECONDARY CLARIFIER DEWATERING PUMP	
340N101	RNG-33088	DI	PLC-2	RUNNING	SECONDARY CLARIFIER DEWATERING PUMP	
340N101	TSH-33088	DI	PLC-2	HI TEMP	SECONDARY CLARIFIER DEWATERING PUMP	
PLC-2	**Total DI Points = 21**					
050N102	RUN-34033	DO	PLC-2	RUN	WAS PUMP 1	
050N102	RUN-34034	DO	PLC-2	RUN	WAS PUMP 2	
340N101	RUN-33088	DO	PLC-2	RUN	SECONDARY CLARIFIER DEWATERING PUMP	
PLC-2	**Total DO Points = 3**					

PLC I/O Listing for PLC-420

Drawing	Tag	I/O	Location	Description	Service	(E/F)
420N901	PQM-42001		PLC-420		SWITCHGEAR POWER QUALITY MANANGEMENT	
PLC-420	**Total Points = 1**					
420N101	F-42003	AI	PLC-420		MAGNETIC FLOW METER	
420N101	PIT-42002	AI	PLC-420		PRESSURE TRANSMITTER	
420N101	SPDF-42001	AI	PLC-420	SPEED FBK	SLUDGE STORAGE PUMP 1	
420N102	PIT-42005	AI	PLC-420		PRESSURE TRANSMITTER	
420N102	SPDF-42004	AI	PLC-420	SPEED FBK	SLUDGE STORAGE PUMP 2	
420N803	T-42033	AI	PLC-420		TEMPERATURE TRANSMITTER	
440N101	L-44001	AI	PLC-420		RADAR	
440N101	LIT-44002	AI	PLC-420		RADAR	
440N101	SPDF-44001	AI	PLC-420	SPEED FBK	SLUDGE STORAGE TANK 1 MIXER	
440N102	L-44005	AI	PLC-420		RADAR	
440N102	LIT-44006	AI	PLC-420		RADAR	
440N102	SPDF-44005	AI	PLC-420	SPEED FBK	SLUDGE STORAGE TANK 2 MIXER	
PLC-420	**Total AI Points = 12**					
420N101	SPDC-42001	AO	PLC-420	SPEED CMD	SLUDGE STORAGE PUMP 1	
420N102	SPDC-42004	AO	PLC-420	SPEED CMD	SLUDGE STORAGE PUMP 2	
440N101	SPDC-44001	AO	PLC-420	SPEED CMD	SLUDGE STORAGE TANK 1 MIXER	
440N102	SPDC-44005	AO	PLC-420	SPEED CMD	SLUDGE STORAGE TANK 2 MIXER	
PLC-420	**Total AO Points = 4**					

PLC I/O Listing for PLC-420

Drawing	Tag	I/O	Location	Description	Service	(E/F)
420N101	FAIL-42001	DI	PLC-420	FAILED	SLUDGE STORAGE PUMP 1	
420N101	PSH-42002	DI	PLC-420		PRESSURE SWITCH HIGH	
420N101	REM-42001	DI	PLC-420	REMOTE	SLUDGE STORAGE PUMP 1	
420N101	RNG-42001	DI	PLC-420	RUNNING	SLUDGE STORAGE PUMP 1	
420N101	TSH-42001	DI	PLC-420	HI TEMP	SLUDGE STORAGE PUMP 1	
420N102	FAIL-42004	DI	PLC-420	FAILED	SLUDGE STORAGE PUMP 2	
420N102	PSH-42005	DI	PLC-420		PRESSURE SWITCH HIGH	
420N102	REM-42004	DI	PLC-420	REMOTE	SLUDGE STORAGE PUMP 2	
420N102	RNG-42004	DI	PLC-420	RUNNING	SLUDGE STORAGE PUMP 2	
420N102	TSH-42004	DI	PLC-420	HI TEMP	SLUDGE STORAGE PUMP 2	
420N801	FAIL-42010	DI	PLC-420	FAULT	SLUDGE STORAGE BUILDING SUMP PUMP 1	
420N801	FAIL-42011	DI	PLC-420	FAULT	SLUDGE STORAGE BUILDING SUMP PUMP 2	
420N801	LSH-42010	DI	PLC-420		SUMP PUMP LEVEL SWITCH HIGH	
420N801	RNG-42010	DI	PLC-420	RUNNING	SLUDGE STORAGE BUILDING SUMP PUMP 1	
420N801	RNG-42011	DI	PLC-420	RUNNING	SLUDGE STORAGE BUILDING SUMP PUMP 2	
420N802	FAIL-42032	DI	PLC-420	FAULT	SLUDGE STORAGE BUILDING EXHAUST FAN	
420N802	FAIL-42033	DI	PLC-420	FAULT	SLUDGE STORAGE BUILDING SUPPLY FAN	
420N802	ISH-42032	DI	PLC-420	FAN CURRENT OK	SLUDGE STORAGE BUILDING EXHAUST FAN	
420N802	ISH-42033	DI	PLC-420	FAN CURRENT OK	SLUDGE STORAGE BUILDING SUPPLY FAN	
420N802	REM-42032	DI	PLC-420	REMOTE	SLUDGE STORAGE BUILDING EXHAUST FAN	
420N802	REM-42033	DI	PLC-420	REMOTE	SLUDGE STORAGE BUILDING SUPPLY FAN	
420N802	RNG-42032	DI	PLC-420	RUNNING	SLUDGE STORAGE BUILDING EXHAUST FAN	
420N802	RNG-42033	DI	PLC-420	RUNNING	SLUDGE STORAGE BUILDING SUPPLY FAN	
420N804	RST-42021	DI	PLC-420	RESET	GO/NO-GO PANEL	
420N804	XA-42021	DI	PLC-420	NO-GO ALARM	GO/NO-GO PANEL	
420N901	AUX1B-42001	DI	PLC-420	SG-3201 BUS A	AUTOMATIC TRANSFER SWITCH	
420N901	AUX2A-42001	DI	PLC-420	ATS FAIL	AUTOMATIC TRANSFER SWITCH	

PLC I/O Listing for PLC-420

Drawing	Tag	I/O	Location	Description	Service	(E/F)
420N901	AUX2B-42001	DI	PLC-420	ATS BYPASS	AUTOMATIC TRANSFER SWITCH	
420N901	AUX3-42001	DI	PLC-420	ALARM SPD	SWITCHGEAR SURGE PROTECTIVE DEVICE	
420N901	AUX3-42001	DI	PLC-420	SG-3201 BUS A	AUTOMATIC TRANSFER SWITCH	
420N901	AUX3A-42001	DI	PLC-420	SG-3201 BUS B	AUTOMATIC TRANSFER SWITCH	
420N901	AUX4-42001	DI	PLC-420	SG-3201 BUS B	AUTOMATIC TRANSFER SWITCH	
420N901	SD-42001	DI	PLC-420	SMOKE	FIRE ALARM CONTROL PANEL	
420N901	XST-42001	DI	PLC-420	TROUBLE	FIRE ALARM CONTROL PANEL	
420N902	JS1-42020	DI	PLC-420	PWR SUP OK	PCM CABINET	
420N902	JS2-42020	DI	PLC-420	PWR SUP OK	PCM CABINET	
420N902	JS3-42020	DI	PLC-420	REDUNDANCY OK	PCM CABINET	
420N902	JS4-42020	DI	PLC-420	ACB OK	PCM CABINET	
420N902	JS5-42020	DI	PLC-420	ON UPS POWER	UPS POWER STATUS	
420N902	TSH-42020	DI	PLC-420	HIGH CABINET TEMP	PCM CABINET	
420N902	XA1-42020	DI	PLC-420	SPD FAIL	PCM CABINET	
420N902	XA2-42020	DI	PLC-420	SPD FAIL	PCM CABINET	
420N902	XA3-42020	DI	PLC-420	LOW BATTERY	UPS POWER STATUS	
420N902	XA4-42020	DI	PLC-420	ON BATTERY	UPS POWER STATUS	
420N902	ZS-42020	DI	PLC-420	INTRUSION	PCM CABINET	
440N101	FAIL-44001	DI	PLC-420	FAILED	SLUDGE STORAGE TANK 1 MIXER	
440N101	REM-44001	DI	PLC-420	REMOTE	SLUDGE STORAGE TANK 1 MIXER	
440N101	RNG-44001	DI	PLC-420	RUNNING	SLUDGE STORAGE TANK 1 MIXER	
440N101	TSH-44001	DI	PLC-420	HI TEMP	SLUDGE STORAGE TANK 1 MIXER	
440N101	XA1-44004	DI	PLC-420	COMMON FAULT		
440N102	FAIL-44005	DI	PLC-420	FAILED	SLUDGE STORAGE TANK 2 MIXER	
440N102	REM-44005	DI	PLC-420	REMOTE	SLUDGE STORAGE TANK 2 MIXER	
440N102	RNG-44005	DI	PLC-420	RUNNING	SLUDGE STORAGE TANK 2 MIXER	
440N102	TSH-44005	DI	PLC-420	HI TEMP	SLUDGE STORAGE TANK 2 MIXER	

PLC I/O Listing for PLC-420

Drawing	Tag	I/O	Location	Description	Service	(E/F)
440N801	AUTO-44020	DI	PLC-420	AUTO	SLUDGE STORAGE TANK ODOR CONTROL SYSTEM	
440N801	FAIL-44020	DI	PLC-420	FAULT	SLUDGE STORAGE TANK ODOR CONTROL SYSTEM	
440N801	RNG-44020	DI	PLC-420	RUNNING	SLUDGE STORAGE TANK ODOR CONTROL SYSTEM	
PLC-420	**Total DI Points = 57**					
420N101	RUN-42001	DO	PLC-420	RUN	SLUDGE STORAGE PUMP 1	
420N101	ZCO-42001	DO	PLC-420	OPEN	SOLENOID VALVE	
420N101	ZCO-42002	DO	PLC-420	OPEN	SOLENOID VALVE	
420N102	RUN-42004	DO	PLC-420	RUN	SLUDGE STORAGE PUMP 2	
420N802	RUN-42032	DO	PLC-420	RUN	SLUDGE STORAGE BUILDING EXHAUST FAN	
420N802	RUN-42033	DO	PLC-420	RUN	SLUDGE STORAGE BUILDING SUPPLY FAN	
440N101	RUN-44001	DO	PLC-420	RUN	SLUDGE STORAGE TANK 1 MIXER	
440N101	ZCO-44001	DO	PLC-420	OPEN		
440N102	RUN-44005	DO	PLC-420	RUN	SLUDGE STORAGE TANK 2 MIXER	
440N102	ZCO-44005	DO	PLC-420	OPEN		
440N801	RUN-44020	DO	PLC-420	RUN	SLUDGE STORAGE TANK ODOR CONTROL SYSTEM	
PLC-420	**Total DO Points = 11**					

PLC I/O Listing for RIO-53A

Drawing	Tag	I/O	Location	Description	Service	(E/F)
530N102	PIT-53061	AI	RIO-53A		PRESSURE TRANSMITTER	
530N102	SPDF-53061	AI	RIO-53A	SPEED FBK	THICKENED SLUDGE PUMP 1	
530N103	PIT-53062	AI	RIO-53A		PRESSURE TRANSMITTER	
530N103	SPDF-53062	AI	RIO-53A	SPEED FBK	THICKENED SLUDGE PUMP 2	
530N104	A-53011	AI	RIO-53A	SLDG DENSITY	SLUDGE DENSITY METER	
530N104	F-53013	AI	RIO-53A		MAGNETIC FLOW METER	
530N104	SPDF-53012	AI	RIO-53A	SPEED FBK	INLINE POLYMER MIXER	
RIO-53A	**Total AI Points = 7**					
530N102	SPDC-53061	AO	RIO-53A	SPEED CMD	THICKENED SLUDGE PUMP 1	
530N103	SPDC-53062	AO	RIO-53A	SPEED CMD	THICKENED SLUDGE PUMP 2	
530N104	SPDC-53012	AO	RIO-53A	SPEED CMD	INLINE POLYMER MIXER	
RIO-53A	**Total AO Points = 3**					

PLC I/O Listing for RIO-53A

Drawing	Tag	I/O	Location	Description	Service	(E/F)
530N101	LSH-53001	DI	RIO-53A		LEVEL SWITCH HIGH	E
530N101	LSH-53002	DI	RIO-53A		LEVEL SWITCH HIGH	E
530N102	FAIL-53061	DI	RIO-53A	FAILED	THICKENED SLUDGE PUMP 1	
530N102	PSH-53061	DI	RIO-53A		PRESSURE SWITCH HIGH	
530N102	REM-53061	DI	RIO-53A	REMOTE	THICKENED SLUDGE PUMP 1	
530N102	RNG-53061	DI	RIO-53A	RUNNING	THICKENED SLUDGE PUMP 1	
530N102	TSH-53061	DI	RIO-53A	HI TEMP	THICKENED SLUDGE PUMP 1	
530N103	FAIL-53062	DI	RIO-53A	FAILED	THICKENED SLUDGE PUMP 2	
530N103	PSH-53062	DI	RIO-53A		PRESSURE SWITCH HIGH	
530N103	REM-53062	DI	RIO-53A	REMOTE	THICKENED SLUDGE PUMP 2	
530N103	RNG-53062	DI	RIO-53A	RUNNING	THICKENED SLUDGE PUMP 2	
530N103	TSH-53062	DI	RIO-53A	HI TEMP	THICKENED SLUDGE PUMP 2	
530N104	FAIL-53012	DI	RIO-53A	FAILED	INLINE POLYMER MIXER	
530N104	REM-53010	DI	RIO-53A	REMOTE	TSL SAMPLE VALVE	
530N104	REM-53012	DI	RIO-53A	REMOTE	INLINE POLYMER MIXER	
530N104	REM-53014	DI	RIO-53A	REMOTE	SST BYPASS VALVE	
530N104	REM-53015	DI	RIO-53A	REMOTE	SST FEED VALVE	
530N104	REM-53016	DI	RIO-53A	REMOTE	SST RETURN VALVE	
530N104	RNG-53012	DI	RIO-53A	RUNNING	INLINE POLYMER MIXER	
530N104	TSH-53012	DI	RIO-53A	HIGH TEMP	INLINE POLYMER MIXER	
530N104	ZSC-53010	DI	RIO-53A	CLOSED	TSL SAMPLE VALVE	
530N104	ZSC-53014	DI	RIO-53A	CLOSED	SST BYPASS VALVE	
530N104	ZSC-53015	DI	RIO-53A	CLOSED	SST FEED VALVE	
530N104	ZSC-53016	DI	RIO-53A	CLOSED	SST RETURN VALVE	
530N104	ZSO-53010	DI	RIO-53A	OPENED	TSL SAMPLE VALVE	
530N104	ZSO-53014	DI	RIO-53A	OPENED	SST BYPASS VALVE	
530N104	ZSO-53015	DI	RIO-53A	OPENED	SST FEED VALVE	

PLC I/O Listing for RIO-53A

Drawing	Tag	I/O	Location	Description	Service	(E/F)
530N104	ZSO-53016	DI	RIO-53A	OPENED	SST RETURN VALVE	
530N801	FAIL-53020	DI	RIO-53A	FAULT	SUMP PUMP 1	
530N801	FAIL-53021	DI	RIO-53A	FAULT	SUMP PUMP 2	
530N801	LSH-53020	DI	RIO-53A		SUMP PUMP LEVEL SWITCH HIGH	
530N801	RNG-53020	DI	RIO-53A	RUNNING	SUMP PUMP 1	
530N801	RNG-53021	DI	RIO-53A	RUNNING	SUMP PUMP 2	
RIO-53A	**Total DI Points = 33**					
530N101	SVO-53001	DO	RIO-53A	OPEN	THICKENED SLUDGE TANK 1 VALVE	
530N101	SVO-53002	DO	RIO-53A	OPEN	THICKENED SLUDGE TANK 2 VALVE	
530N102	RUN-53061	DO	RIO-53A	RUN	THICKENED SLUDGE PUMP 1	
530N103	RUN-53062	DO	RIO-53A	RUN	THICKENED SLUDGE PUMP 2	
530N104	RUN-53012	DO	RIO-53A	RUN	INLINE POLYMER MIXER	
530N104	SVO-53011	DO	RIO-53A	OPEN	SLUDGE METERING INTAKE VALVE	
530N104	ZCC-53010	DO	RIO-53A	CLOSE	TSL SAMPLE VALVE	
530N104	ZCC-53014	DO	RIO-53A	CLOSE	SST BYPASS VALVE	
530N104	ZCC-53015	DO	RIO-53A	CLOSE	SST FEED VALVE	
530N104	ZCC-53016	DO	RIO-53A	CLOSE	SST RETURN VALVE	
530N104	ZCO-53010	DO	RIO-53A	OPEN	TSL SAMPLE VALVE	
530N104	ZCO-53014	DO	RIO-53A	OPEN	SST BYPASS VALVE	
530N104	ZCO-53015	DO	RIO-53A	OPEN	SST FEED VALVE	
530N104	ZCO-53016	DO	RIO-53A	OPEN	SST RETURN VALVE	
RIO-53A	**Total DO Points = 14**					

SECTION 41_22_24

MONORAIL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Monorail system with connections to structural members of the building.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. Specifications for Design, Fabrication, and Erection of Structural Steel for Buildings.

B. American Society of Mechanical Engineers (ASME):
   1. B30.11 - Monorails and Underhung Cranes.
   2. B30.16 - Overhead Hoists (Underhung).

C. American Welding Society (AWS).

D. Monorail Manufacturers Association (MMA):
   1. MH27.1 - Specifications for Underhung Cranes and Monorail Systems.

E. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

F. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
      a. Article 610 - Cranes and Hoists.

G. Occupational Safety and Health Administration (OSHA).

1.03 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Calculations.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. As specified in Section 01_60_00 - Product Requirements:
   1. Product data.
   2. Shop Drawings:
      a. Include support types, sizes, spacing, bridging, connections, anchoring, bearing plates, and erection instructions.

C. Delegated Design Submittals:
   1. Structural calculations for rails and anchorage.

D. Installation instructions:
   1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
   2. Provide manufacturer's installation instructions.

E. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
   3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
   4. Manufacturer's Certificate of Functional Compliance as specified in Section 01_75_17 - Commissioning.
   5. Certificate of tests conducted by the monorail manufacturer in accordance with industry standards and federal regulations.
   6. Certificate of local authority having jurisdiction, if required.
   7. Load test certificate.

F. Owner Training Submittals:
   1. As specified in Section 01_75_17 - Commissioning.

G. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements, Section 46_05_10 - Common Work Results for Mechanical, and the manufacturer's instructions.

B. Assemble, paint, test, and adjust monorail system in the manufacturer's shop before shipment, as far as practical.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.07 SEQUENCING AND SCHEDULING

A. Coordinate Work with restrictions as specified in Section 01_14_00 - Work Restrictions.

1.08 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements and Section 46_05_10 - Common Work Results for Mechanical Equipment.

2.02 MANUFACTURERS

A. One of the following or equal:
   1. ACCO, Trambeam Monorail Systems.
   2. Cleveland Tramrail by Gorbel.

2.03 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
   1. Hoisting system: In accordance with ASME B30.11, ASME B30.16, and OSHA standards.
   2. Structural steel construction: In accordance with AISC specifications.
   3. Safety factor of castings, forgings, and stampings: Minimum 5 with regard to ultimate strength.
   4. Perform welding in accordance with AWS standards.
   5. Electrification in accordance with NEC 610.
   6. Design equipment in accordance with MMA MH27.1.
   7. Maximum vertical deflection of monorail beam: Maximum span of monorail beam divided by 450.
   8. Maximum lateral deflection of monorail beam: Maximum span of monorail beam divided by 360 when subjected to a lateral load of 20 percent of the lifted load.

B. Performance requirements:
   1. Service classification: Class A, standby or infrequent.
   2. Capacity: 1.5 ton.
   3. Arrange working parts for convenient inspection, lubrication, adjustment, repair, or replacement.

2.04 MONORAIL

A. Stops and bumpers: Adequate to absorb energy of and stop moving trolley at end of permitted travel.

B. Hangers: Adjustable, able to level and accurately align system within 1/8-inch tolerance, able to support monorail from building structure.

C. Length: As indicated on the Drawings.

D. Labeling: Paint hoist capacity on monorail with minimum 4-inch high letters and numbers where clearly visible from operating floor.

2.05 TROLLEY HOISTS

A. Type: Combination electric motor-driven trolleys and hoists, single-speed with trolley cushioned start, including mechanical brake, electrical brake, and upper hoist limit stop and load limiting device.

B. Hoisting speed: 10 feet per minute.

C. Distance from bottom of rail to inside of hook: Maximum 25 inches with hook in fully raised position.

D. Trolleys wheels: Single-flanged; forged steel, hardened to 425 Brinell; fitted with anti-friction bearings with lifetime seals; suitable for adjustment to monorails.

E. Safety lugs: Add to the manufacturer's standard design.

F. Motors: 460 volt, 3-phase, 60 hertz, totally enclosed non-ventilated (TENV), squirrel-cage induction type operating at maximum 1,800 revolutions per minute, with Class B or F insulation, horsepower as follows:
   1. Hoist: 3.
   2. Trolley: 3/4.
      a. Actual horsepower requirement not to exceed the specified motor horsepower.

G. Drive units: Specially designed for monorail service with cushioned stop holding brakes.

H. Hoisting drum: Steel or cast iron with machined, 1/2 rope diameter deep grooves; adequate to provide minimum 2 complete rope wraps on drum with hook in lowest position, and to accommodate full length of rope without overlapping when in highest position.

I. Hoist drive speed reducer: With heat-treated steel helical gears; oil-lubricated with oiltight cases; shafts running in anti-friction bearings.

J. Limit switches and overload device: Manufacturer's standard.

K. Hoisting rope: Specifically designed for specified service loads; preformed, improved plow steel with fiber core; double-reeved.

L. Hoisting block: Steel with forged or cast steel hook supported on ball or roller bearings for true vertical lift.

M. Hook: Safety type, able to rotate freely on bearing support with heavy-duty type safety latches.

N. Bottom block: Shrouded.

O. Lifting distance: 25 feet.

2.06 ELECTRIFICATION AND CONTROL

A. Electrification type: Cable and spring-loaded swiveled cable reel-mounted on the structure.

B. Cable run: From junction box to cable reel, then to control unit.

C. Control unit: Pendant pushbutton station hanging from hoist to maximum 4 feet above operation floor.

D. Control voltage: 120 volts alternating current, supplied from transformer on hoist.

E. Pushbuttons: Momentary-contact, maintain-pressure, automatically de-energizing upon relaxation of pressure; number and functions as follows:
   1. Pushbuttons for hoisting: 2; one for each direction.
   2. Pushbuttons for trolley: 2; one for each direction.

F. Enclosures for control unit, electrical control, and reel: NEMA Type 4X.

G. Control unit support: Steel cable.

H. Control accessories:
   1. Geared limit switch able to limit up and down travel with second switch operated by hook to stop hoist when highest safe point is reached.
   2. Magnetic contactors for up and down operation and control.

I. Junction boxes: Suitable for connection of field services with ground pads.

2.07 FINISHES

A. Products with a factory or shop applied coating system:
   1. Coat products with the manufacturer's standard surface preparation and applied permanent coating system.
   2. Items subject to sunlight shall have a ultraviolet stable topcoat.
   3. Coating system shall provide 10-year corrosion free protection without significant defects in atmospheric exposure.
   4. Color and gloss: Manufacturer' standard.
   5. Unexposed surfaces that require coating, such as the interior of cabinets, enclosures and equipment shall be given the manufacturer's standard permanent coated finish.
   6. The following items shall not be coated:
      a. Running surfaces of beams and wheels.

2.08 SOURCE QUALITY CONTROL

A. Source Testing (Factory Acceptance Tests):
   1. Not witnessed.
   2. As specified in Section 01_75_17 - Commissioning.
   3. Tests required to comply with MMA standards and federal regulations.
   4. Test as specified in Section 46_05_94 - Mechanical Equipment Testing.
   5. Furnish test reports and the Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

B. Do not use monorail to handle loads until the load test certificate has been received.

C. Do not use monorail system for construction.

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install equipment as indicated on the Drawings and the manufacturer's written installation instructions.

B. Repair damaged areas of coated surfaces with compatible materials to equal thickness and color match of undamaged areas.

C. Furnish Manufacturer's Certificate of Installation Verification.

3.04 FIELD QUALITY CONTROL

A. Functional Testing:
   1. Witnessed by:
      a. The Owner.
      b. An OSHA certified representative from the equipment manufacturer.
      c. Local AHJ.
   2. Testing requirements:
      a. Test with not less than 110 percent nor more than 125 percent of rated load capacity.
      b. Provide load and slings for tests. Remove after tests are complete.
      c. Operate monorail through a full lift and lowering cycle, and travel of trolley to demonstrate functions of hoisting, braking, and traveling.
         1) Monorail shall function quietly, smoothly, and safely.
   3. Furnish test reports and the Manufacturer's Certificate of Functional Compliance.

3.05 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations and Maintenance: 1.

END OF SECTION

SECTION 43_23_31.30

VERTICAL NON-CLOG CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Vertical dry pit, non-clog (Francis-Vane) or mixed flow, flexibly coupled or intermediate shaft driven centrifugal pumps with drivers and features as scheduled.

B. As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   5. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   6. B148 - Standard Specification for Aluminum-Bronze Sand Castings.
   7. B505 - Standard Specification for Copper Alloy Continuous Castings.
   8. B763 - Standard Specification for Copper Alloy Sand Castings for Valve Applications.
   9. E10 - Standard Test Method for Brinell Hardness of Metallic Materials.

D. Hydraulic Institute (HI):
   1. 9.1-9.5 - Pumps - General Guidelines.
   2. 14.1-14.2 - Rotodynamic Pumps for Nomenclature and Definitions.
   3. 14.3 - Rotodynamic Pumps for Design and Application.
   4. 14.6 - Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section have the indicated meaning.
   1. Allowable Operating Region (AOR): The region over which the service life of the pump is not seriously compromised by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.
   2. Preferred Operating Region (POR): The region over which the service life of the pump will not be significantly affected by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.
   3. Pump Head (Total Dynamic Head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 9.1-9.5, 14.1-14.2, 14.3, 14.6, and as modified in this Section.
   4. Suction Head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

C. Rotordynamic analysis.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria.
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

C. Commissioning Submittals:
   1. As specified in Section 01_75_17 - Commissioning, including the following:
      a. Manufacturer's representative qualifications.
      b. Certificates.
         1) Requirements as specified in this Section.
      c. Test Plans.
         1) Test requirements as specified in this Section.
      d. Test Reports.
      e. Manufacturer's representatives field notes and data.
      f. Owner training.

D. Product Submittals:
   1. As specified in Section 01_60_00 - Product Requirements.
   2. Product data.
   3. Shop Drawings.
   4. Manufacturer's instructions.
   5. Calculations.
   6. Schedules.

E. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements, Section 46_05_10 - Common Work Results for Mechanical and the manufacturer's instructions.

1.07 SYSTEM DESCRIPTION

A. Vertical, centrifugal, non-clog (Francis-Vane) or mixed flow pump components:
   1. Pump, driver, motors, and drive arrangements as specified or as scheduled with drive shafts, U-joints, intermediate bearings, seals or packing, couplings, base plates, guards, supports, anchor bolts, necessary valves, gauges, taps, lifting eyes, stands, and other items as required for a complete and operational system.

B. Design requirements:
   1. Pump performance characteristics:
      a. As specified in the Pump Schedule.
      b. Performance tolerances shall be the same as the test tolerances specified in Section 46_05_94 - Mechanical Equipment Testing.
   2. Motor characteristics: As specified in the Pump Schedule.

1.08 PROJECT CONDITIONS

A. Environmental requirements: As specified in Section 01_81_50 - Design Criteria.

B. The pump will be installed in the secondary sludge pump station room, approximately in the footprint of the demolished WAS pump P-34032.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work with restrictions specified in Section 01_14_00 - Work Restrictions.

B. Coordinate work as specified in Section 01_75_17 - Commissioning.

1.10 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pump: One of the following or equal:
   1. Xylem (Flygt), equivalent product.
   2. Fairbanks Nijhuis, Series number as scheduled.
   3. Flowserve (Ingersoll-Dresser Pumps/Worthington), equivalent product.

B. Substitution requirements:
   1. Provide references from a minimum of 2 pump installations currently having operated at least 2 years with the same drive configuration and project conditions of head, flow, and speed.

C. Manufacturer's representatives' requirements:
   1. As specified in Section 01_75_17 - Commissioning and this Section.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Vertical, centrifugal, non-clog (Francis-Vane) or mixed flow pump components:
   1. Pumps, drivers, motors, and drive arrangements as specified or as scheduled with drive shafts, U-joints, intermediate bearings, seals or packing, couplings, base plates, guards, supports, anchor bolts, necessary valves, gauges, taps, lifting eyes, stands, and other items as required for a complete and operational system.

B. Design requirements:
   1. Pump performance characteristics:
      a. As specified in the Pump Schedule.
      b. Rotordynamic analysis level: As scheduled and as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
         1) Vibration analysis expert: Provide when scheduled.
      c. All required conditions (flow/head) shall be within the pump manufacturer's Allowable Operating Region (AOR).
      d. Performance tolerances shall be the same as the test tolerances specified in Section 46_05_94 - Mechanical Equipment Testing.
   2. Motor characteristics: As specified in the Pump Schedule.

2.03 MATERIALS

A. General: Materials in the Pump Schedule shall be the type and grade as specified below.
   1. Cast iron: ASTM A48, Class 30 minimum.
   2. Nickel cast iron: ASTM A48, minimum Class 30, cast iron with 3 percent nickel.
   3. Iron-chromium alloy: ASTM A743, Grade CA40.
   4. Bronze or leaded tin bronze: ASTM B505, Alloy C92700.
   5. Aluminum bronze: ASTM B148 or B763, Alloy C95200.
   6. Stainless steel: ASTM A276, type as scheduled.
   7. Neoprene: Polychloroprene rubber.
   8. Structural steel: ASTM A283, Grade D.
   9. Steel: ASTM A108, Grade as scheduled.

2.04 GENERAL PUMP CONSTRUCTION

A. Type: Heavy-duty, vertical, non-clog (Francis-Vane) or mixed flow (as specified) centrifugal type pumps.

B. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

C. Each pump shall be provided with lifting eyebolts.

D. Other requirements:
   1. Vibration: As specified in Section 46_05_94 - Mechanical Equipment Testing.

2.05 PUMP CASINGS

A. Type: 1-piece volute-type with integral suction and discharge nozzles.

B. Material: As scheduled.

C. Construction: Of sufficient strength, weight, and thickness to provide accurate alignment, prevent excessive deflection, and support drive motor.

D. Rotating assembly: Removable without disturbing suction or discharge connections.

E. Design Working Pressure: Minimum 1.10 times maximum shutoff total dynamic head with maximum installable impeller diameter at maximum operating speed plus maximum suction static head, as Scheduled.

F. Discharge: Tangential to casing or centered on casing when space permits acceptable rearrangement of piping.

G. Suction and discharge piping connections: Flanged meeting ASME B16.1, Class 125, or ASME B16.5, Class 150, or higher pressure class as required to meet Design Working Pressure.

H. Handholes: Provide to permit inspection and cleaning of pump interior; bolted cover with inner contour that matches contour of casings; minimum 5 inch diameter when pump size permits this handhole.

I. Vent and taps:
   1. Provide castings with both 3/4-inch threaded high point and low point drain taps.
   2. Provide 1/2-inch threaded tap with valve and pressure gauge on the suction and discharge flanges.

J. Hydrostatic test: 5-minute hydrostatic test at minimum 1.5 times Design Working Pressure.

K. Suction elbow:
   1. As indicated on the Drawings.

2. Cast iron with removable clean out access cover.
3. Provide reducing elbow to mate with pump as required by the pump manufacturer.

2.06 IMPELLERS

A. Type: As scheduled.

B. Material: As scheduled.

C. Maximum number of vanes: As scheduled.

D. Design smooth water passages to prevent clogging by stringy or fibrous materials. Passages shall be capable of passing solids with sphere size as scheduled.

E. Method of securing to shafts: Keyed and secured by bronze nut locked in place, but readily removable without use of special tools.

F. Adjustment of axial clearance: Through jacking screws and lock nuts placed between frame and outboard bearing housing or by shims held in place by frame housing.

G. Rotation: Clockwise looking from driver, unless otherwise indicated on the Drawings.

H. Balance: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment and vibration criteria as specified in Section 46_05_94 - Mechanical Equipment Testing.

2.07 WEAR RINGS

A. Materials:
1. Impeller wear ring: As scheduled with a Brinell Hardness Number of 350 to 380 or at least 50 Brinell Hardness Number less than the casing or suction head wear ring Brinell Hardness Number when tested in accordance with ASTM E10.
2. Casing or suction head wear ring: As scheduled with a minimum Brinell Hardness Number of 450 when tested in accordance with ASTM E10.

B. Features:
1. Able to allow compensation for minimum 1/8-inch wear.
2. Provided with wearing surfaces normal to axis of rotation (perpendicular to shaft axis).
3. Removable.
4. Fastened with recessed screws to prevent relative rotation.

2.08 PUMP SHAFTS

A. Material: As scheduled, turned, ground, and polished.

B. Strength: Able to withstand minimum 1.5 times maximum operating torque and other loads.

C. Resonant frequency: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment and Section 46_05_94 - Mechanical Equipment Testing.

D. Deflection: Maximum 0.002 inches under operating conditions.

E. Impeller attachment: Taper fitted at impeller with key and bolt for securing impeller.

F. Shaft sleeve:
   1. As scheduled, with minimum Brinell Hardness of 450 when tested in accordance with ASTM E10.
   2. Renewable, key locked in stuffing box, gland area, and bearings.
   3. Able to protect shaft from pumped liquid and wear.

2.09 STUFFING BOXES

A. Size: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

B. Materials: Same as pump casing.

C. Stuffing box: Provide separate stuffing box housing (not integral to the rear liner or wear plate) suitable for shaft seal type scheduled.

D. Shaft seal type: Seal water will be required as shown in drawings and as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

2.10 BEARINGS AND BEARING FRAME

A. Bearing type: Anti-friction meeting ABMA standards; self-aligning spherical roller type radial bearings; angular contact ball type, or tapered roller for thrust bearings.

B. Bearing lubrication:
   1. When grease is lubrication scheduled, provide:
      a. External grease fittings with grease relief pipe.
      b. Lip type grease seals and labyrinth type grease deflectors at both ends of bearing housings, able to prevent entrance of contaminants.
   2. When oil lubrication is scheduled, provide:
      a. Pressure lubricating system or separate oil reservoir type system.
      b. Oil filler pipe.
      c. External level indicator gauge.
   3. Size sufficiently to safely absorb heat energy normally generated in bearing under maximum ambient temperature of 60 degrees Celsius.

C. Bearing life: Minimum L10 life of 100,000 hours at rated design point or 24,000 hours in accordance with ABMA 9 or 11 at bearing design load imposed by pump shutoff with maximum sized impeller at rated speed, whichever provides longest bearing life in intended service.

D. Pump bearing frames:
   1. Material: As scheduled.
   2. 1-piece rigid construction with bearing housing at outboard (pump) end, and end cover or housing at inboard (driver) end.

E. Inboard bearing frame drain hole: Tapped, located as low as possible to drain leakage when adjacent to packing or seal.

2.11 COUPLINGS

A. Types: As scheduled and specified in Section 46_05_10 - Common Work Results for Mechanical Equipment:
   1. Close coupled:
      a. Pump and motor share 1 common shaft.
      b. Motor bearings shall absorb pump thrusts loads.
   2. Short coupled:
      a. Pump and motor have separate shafts and is connected by a flexible coupling.
      b. Pump has an integral bearing housing to absorb pump thrust.
      c. Motor shall have a flange adaptor that mounts to the body of the pump and shall be supported by the pump bearing housing.
   3. Intermediate shaft coupled:
      a. Pump and motor have separate shafts, intermediate shafts, bearing, supports, and is connected by a U-joint.
      b. Pump has an integral bearing housing to absorb pump thrust.
      c. Motor shall be mounted and supported independently of the pump.

B. Flexible coupling life: Infinite at up to 0.3-degree misalignment angle total or per disk for disk type at maximum operating loads.

C. Design coupling to withstand a minimum of 1.5 times the maximum operating torque and other imposed loads.

D. Components for driver connected through intermediate shafting: When scheduled, provide drive shafting, couplings, intermediate bearing supports, U-joints, and separate motor/driver support; arranged in accordance with general arrangement indicated on the Drawings.

E. Motor/driver and pump couplings for single intermediate shafts: Flexible disc or other type required to meet torsional vibration requirements.

2.12 SUPPORTS, PEDESTALS, AND BASEPLATES

A. Type: As scheduled and specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

B. Materials: Same as pump casing or ASTM A283 steel, hot-dip galvanized after fabrication and coated as specified in Section 09_96_01 - High-Performance Coatings.

C. Pump and driver support strength: Able to withstand minimum 1.5 times maximum imposed operating loads or imposed seismic loads, whichever is greater.

D. Configuration: Allow easy access to stuffing boxes, bearing frames, and couplings; suction elbow flange at least 2 inches above pump foundation.

E. Short coupled motor pedestal attachment: Bolted to pump pedestal with motor load not transmitted to pump casing.

F. Anchor bolts: As specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.13 EQUIPMENT GUARDS

A. Provide equipment safety guards as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

2.14 DRIVERS

A. Horsepower:
   1. As scheduled.
   2. Listed driver horsepower is the minimum to be supplied.
      a. Increase driver horsepower if required to prevent driver overload while operating at any point of the supplied pump operating head-flow curve including runout.
      b. When scheduled driver is a motor, increase motor horsepower if required to prevent operation in the service factor.
      c. Make structural, mechanical, and electrical changes required to accommodate increased horsepower.

B. Motors: As specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower and as specified in this Section.
   1. RPM: As scheduled.
   2. Enclosure: As scheduled.
   3. Electrical characteristics: As scheduled.
   4. Efficiency, service factor, insulation, and other motor characteristics: As specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.
   5. Motor accessories: As specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower and as specified in this Section.

C. Non-reverse ratchets, type: When scheduled, able to prevent reverse rotation of pump and driver.

2.15 FINISHES

A. Prepare surfaces and apply protective finishes as specified in Section 09_96_01 - High-Performance Coatings.

2.16 SPARE PARTS AND SPECIAL TOOLS

A. For each type or size of pump specified, provide 1 set of special tools required for complete assembly or disassembly of the pump system components.

B. Spare parts: Deliver the following as specified in Section 01_60_00 - Product Requirements:
   1. One pump thrust bearing set.
   2. One pump radial bearing set.
   3. Motor bearing set of each type.
   4. Pump impeller, trimmed to match installed impeller.
   5. One mechanical seal set.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

3.03 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Source Testing.
      b. Manufacturer’s Certificate of Installation and Functionality Compliance.
   2. Manufacturer’s Representative onsite requirements:
      a. Installation: 2 trips, 1-day minimum each.
      b. Functional Testing: 2 trips, 1-day minimum each.
   3. Training:
      a. Maintenance: 4 hours per session, 1 session.
      b. Operation: 2 hours per session, 1 session.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Source Testing (Factory Acceptance Tests):
   1. Not witnessed.
   2. Furnish test reports and Manufacturer’s Certificate of Source Testing.

3. Equipment testing:
    a. Pump:
        1) Performance test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
        2) Vibration test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
        3) Noise test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
        4) Pump casing: 5-minute hydrostatic test at minimum 1.5 times Design Working Pressure.
        5) Motor: Test as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.

D. Installation Verification:
    1. Furnish Manufacturer's Certificate of Installation Verification.

E. Functional Testing:
    1. Equipment testing:
        a. Pump:
            1) Performance test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
            2) Vibration test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
            3) Noise test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
    2. Motor: Test as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.

3.04 PUMP SCHEDULE

Tag Numbers	P-33088
General Characteristics	
Service	Secondary Clarifier Dewatering Pump
Quantity	1
First Named Manufacture Model Number	NSWV
Second Named Manufacture Model Number	5400
Maximum Noise, dBA at 3 feet	85
Torsional Analysis	Not Required
Minimum Pumped Fluid degrees Fahrenheit	50
Normal Pumped Fluid degrees Fahrenheit	70
Maximum Pumped Fluid degrees Fahrenheit	85

Tag Numbers	P-33088
Pump Characteristics	
Impeller Type	Non-clog
Impeller, Maximum Number Vanes	Per Manufacturer
Pass Minimum Sphere Size, Inch	3
Impeller Bearing Lubrication	Grease
Shaft Seal Type	Cartridge-type Double Mechanical
Coupling Type	Short Coupled
Speed Control	Fixed
Maximum Pump rpm	1,185
Minimum Pump rpm	1,185
Suction Elbow Flange Connection	6-inch
Discharge Flange Connection	5 or 6-inch
Rated Design Point (At Maximum rpm):	
Flow, Gallons per Minute	800
Head, Feet	40
Minimum Efficiency, Percent	74
Required Condition 2 (At Maximum rpm):	
Flow Range, Gallons per Minute	1,200 – 1,300
Head, Feet	26
Minimum Efficiency, Percent	62
Required Condition 3 (At Maximum rpm):	
Flow, Gallons per Minute	350
Head Range, Feet	49 - 53
Minimum Efficiency, Percent	55
Other Conditions	
Minimum Shut Off Head, Feet	54
Maximum NPSHr at every Specified Flow, Feet	18
Pump Materials	
Impeller Casing	Cast Iron
Impeller	Cast Iron
Impeller Wear Ring	420 Stainless Steel
Casing or Suction Head Wear Ring	420 Stainless Steel
Shaft	Steel, Gr 1045
Shaft Sleeve	Iron-Chromium Alloy
Pump Bearing Frame	Cast Iron

Tag Numbers	P-33088
Driver Characteristics	
Driver Type	Motor
Drive Arrangement	Short Coupled
Non-reverse Ratchets	None Required
Minimum Driver Horsepower	15
Maximum Driver rpm	1,200
Motor Characteristics (when motor is driver type)	
Inverter Duty Rated	No
Motor Voltage/Phases/Hertz	460/3/60
Enclosure Type	TEFC
Source Testing	
Test Witnessing	Not Witnessed
Performance Test Level	1
Vibration Test Level	1
Noise Test Level	None
Functional Testing	
Performance Test Level	1
Vibration Test Level	1
Noise Test Level	None

END OF SECTION

SECTION 43_23_31.31

RAS PUMP REPLACEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Partial replacement of two existing RAS pumps of vertical dry pit, mixed flow type. Pumps will be replaced in-kind to match existing and include new replacement bare pump inclusive of casing, impeller, rotating assembly, and bearing frame. The existing pump pedestal and suction elbow, intermediate line-shaft, and motor will remain as existing.
   2. Replaced pumps will include Flygt Dynamic Seal which will no longer require seal water. Spare parts are included with Dynamic Seal kits to be installed by the City in the future on the two remaining pumps.

B. As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   5. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   6. B148 - Standard Specification for Aluminum-Bronze Sand Castings.
   7. B505 - Standard Specification for Copper Alloy Continuous Castings.
   8. B763 - Standard Specification for Copper Alloy Sand Castings for Valve Applications.
   9. E10 - Standard Test Method for Brinell Hardness of Metallic Materials.

D. Hydraulic Institute (HI):
   1. 9.1-9.5 - Pumps - General Guidelines.
   2. 14.1-14.2 - Rotodynamic Pumps for Nomenclature and Definitions.

3. 14.3 - Rotodynamic Pumps for Design and Application.
4. 14.6 - Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section have the indicated meaning.
   1. Allowable operating region (AOR): The region over which the service life of the pump is not seriously compromised by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.
   2. Preferred operating region (POR): The region over which the service life of the pump will not be significantly affected by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.
   3. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 9.1-9.5, 14.1-14.2, 14.3, 14.6, and as modified in this Section.
   4. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Product Submittals:
   1. As specified in Section 01_60_00 - Product Requirements.
   2. Product data.
   3. Pump curves:
      a. Shall represent the pump head and efficiency through the entire published curve from shut-off through the limits of the AOR.
      b. Clearly indicate limits of the POR and AOR on the full speed and variable speed curves.
   4. Shop Drawings:
      a. Drawings indicating dimensions, required clearances, location and size of each field connection.
      b. Cut-away drawings.
      c. Parts list.
   5. Calculations.
      a. ABMA 9 or ABMA 11 L10 life for bearings calculations.

C. Installation instructions:
   1. Provide manufacturer's installation instructions.
   2. Detail the complete installation of the equipment, including rigging, moving, setting into place, and grouting.
   3. Leveling and alignment tolerances.

D. Quality Control Submittals:
   1. Manufacturer's representative qualifications.

2. Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
3. Manufacturer's Certificate of Installation Verification as specified in Section 01_75_17 - Commissioning.
4. Manufacturer's Certificate of Functional Compliance as specified in Section 01_75_17 - Commissioning.

E. Owner Training Submittals:
1. As specified in Section 01_75_17 - Commissioning.

F. Operation and maintenance manuals:
1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
2. Include manufacturer and model number of bearings.
3. Include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements, Section 46_05_10 - Common Work Results for Mechanical and the manufacturer's instructions.

1.06 SEQUENCING AND SCHEDULING

A. Coordinate Work with restrictions specified in Section 01_14_00 - Work Restrictions.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following to match existing, no equal:
1. Xylem (Flygt A-C).

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Vertical, centrifugal, mixed flow pump components:
1. Replacement bare pump to match existing inclusive of casing, impeller, rotating assembly, and bearing frame. The existing pump pedestal and suction elbow, intermediate line-shaft, and motor will remain as existing.

B. Design requirements:
1. Pump performance characteristics:
a. As specified in the Pump Schedule.

b. All required conditions (flow/head) shall be within the pump manufacturer's Allowable Operating Region (AOR).
c. Performance tolerances shall be the same as the test tolerances specified in Section 46_05_94 - Mechanical Equipment Testing.

2. Motor characteristics: As specified in the Pump Schedule.

2.03 MATERIALS

A. Materials in the Pump Schedule shall be the type and grade as specified below.
1. Cast iron: ASTM A48, Class 30 minimum.
2. Nickel cast iron: ASTM A48, minimum Class 30, cast iron with 1.5 percent minimum nickel.
3. Iron-chromium alloy: ASTM A743, Grade CA40.
4. Bronze or leaded tin bronze: ASTM B505, Alloy C92700.
5. Aluminum bronze: ASTM B148 or ASTM B763, Alloy C95200.
6. Stainless steel: ASTM A276, type as scheduled.
7. Neoprene: Polychloroprene rubber.
8. Structural steel: ASTM A283, Grade D.
9. Steel: ASTM A108, Grade as scheduled.

2.04 PUMP CONSTRUCTION

A. Heavy-duty, vertical, mixed flow centrifugal type pumps.

B. Each pump shall be equipped with a stainless steel nameplate indicating rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

C. Each pump shall be provided with lifting eyebolts.

D. Other requirements:
1. Vibration: As specified in Section 46_05_94 - Mechanical Equipment Testing.

2.05 PUMP CASINGS

A. 1-piece volute-type with integral suction and discharge nozzles. Integral suction will remain as existing.

B. Material: As scheduled.

C. Construction: Of sufficient strength, weight, and thickness to provide accurate alignment, prevent excessive deflection, and support drive motor.

D. Rotating assembly: Removable without disturbing suction or discharge connections.

E. Design working pressure: Minimum 1.10 times maximum shutoff total dynamic head with maximum installable impeller diameter at maximum operating speed plus maximum suction static head, as Scheduled.

F. Discharge: Tangential to casing to match existing piping arrangement.

G. Discharge piping connections: Flanged meeting ASME B16.1, Class 125, or ASME B16.5, Class 150, or higher pressure class as required to meet design working pressure.

H. Handholes: Provide to permit inspection and cleaning of pump interior; bolted cover with inner contour that matches contour of casings; minimum 5 inch diameter when pump size permits this handhole.

I. Vent and taps:
   1. Provide castings with both 3/4-inch threaded high point and low point drain taps.
   2. Provide 1/2-inch threaded tap with valve and pressure gauge on the discharge flange.

J. Hydrostatic test: 5-minute hydrostatic test at minimum 1.5 times design working pressure.

2.06 IMPELLERS

A. Type: As scheduled.

B. Material: As scheduled.

C. Maximum number of vanes: As scheduled.

D. Design smooth water passages to prevent clogging by stringy or fibrous materials. Passages shall be capable of passing solids with sphere size as scheduled.

E. Method of securing to shafts: Keyed and secured by 18-8 stainless steel nut locked in place, but readily removable without use of special tools.

F. Adjustment of axial clearance: Through jacking screws and lock nuts placed between frame and outboard bearing housing or by shims held in place by frame housing.

G. Rotation: Clockwise looking from driver, unless otherwise indicated on the Drawings.

H. Balance: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment and vibration criteria as specified in Section 46_05_94 - Mechanical Equipment Testing.

2.07 WEAR RINGS

A. Materials:
   1. Impeller wear ring: As scheduled with a Brinell hardness number of 350 to 380 or at least 50 Brinell hardness number less than the casing or suction head wear ring Brinell hardness number when tested in accordance with ASTM E10.
   2. Casing or suction head wear ring: As scheduled with a minimum Brinell hardness number of 450 when tested in accordance with ASTM E10.

B. Features:
   1. Able to allow compensation for minimum 1/8-inch wear.
   2. Provided with wearing surfaces normal to axis of rotation (perpendicular to shaft axis).
   3. Removable.
   4. Fastened with recessed screws to prevent relative rotation.

2.08 PUMP SHAFTS

A. Material: As scheduled, turned, ground, and polished.

B. Able to withstand minimum 1.5 times maximum operating torque and other loads.

C. Resonant frequency: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment and Section 46_05_94 - Mechanical Equipment Testing.

D. Deflection: Maximum 0.002 inches under operating conditions.

E. Impeller attachment: Taper fitted at impeller with key and bolt for securing impeller.

F. Shaft sleeve:
   1. As scheduled, with minimum Brinell hardness number of 450 when tested in accordance with ASTM E10.
   2. Renewable, key locked in stuffing box, gland area, and bearings.
   3. Able to protect shaft from pumped liquid and wear.

2.09 STUFFING BOXES

A. Materials: Same as pump casing.

B. Stuffing box: Provide separate stuffing box housing (not integral to the rear liner or wear plate) suitable for shaft seal type scheduled.

C. Shaft seal type:
   1. Flygt EQUISEAL™ Dynamic Seal.
      a. Features:
         1) Dynamically seals by opposing discharge pressure.
         2) Does not require external seal water.
         3) No metal-to-metal rubbing parts and no critical operating clearances.
         4) Stages: single.

2.10 BEARINGS AND BEARING FRAME

A. Bearing type: Anti-friction meeting ABMA standards; self-aligning spherical roller type radial bearings; angular contact ball type, or tapered roller for thrust bearings.

B. Bearing lubrication:
   1. When grease is lubrication scheduled, provide:
      a. External grease fittings with grease relief pipe.
      b. Lip type grease seals and labyrinth type grease deflectors at both ends of bearing housings, able to prevent entrance of contaminants.
   2. Size sufficiently to safely absorb heat energy normally generated in bearing under maximum ambient temperature of 60 degrees Celsius.

C. Bearing life: Minimum L10 life of 100,000 hours at rated design point or 24,000 hours in accordance with ABMA 9 or ABMA 11 at bearing design load imposed by pump shutoff with maximum sized impeller at rated speed, whichever provides longest bearing life in intended service.

D. Pump bearing frames:
   1. Material: As scheduled.
   2. 1-piece rigid construction with bearing housing at outboard (pump) end, and end cover or housing at inboard (driver) end.

E. Inboard bearing frame drain hole: Tapped, located as low as possible to drain leakage when adjacent to packing or seal.

2.11 COUPLINGS

A. Utilize existing intermediate shaft coupling to connect to new pump shaft.

2.12 FINISHES

A. Prepare surfaces and apply protective finishes as specified in Section 09_96_01 - High-Performance Coatings.

2.13 SPARE PARTS AND SPECIAL TOOLS

A. For each type or size of pump specified, provide 1 set of special tools required for complete assembly or disassembly of the pump system components.

B. Spare parts: Deliver the following as specified in Section 01_60_00 - Product Requirements:
   1. Pump thrust bearing set – Qty 1.
   2. Pump radial bearing set – Qty 1.
   3. Motor bearing set – Qty 1.
   4. Pump impeller, trimmed to match installed impeller – Qty 1.
   5. Drive line U-joint – Qty 1.
   6. Dynamic seal and retrofit kit for remaining two existing pumps – Qty 2.
   7. Intermediate drive shaft U-joint – Qty 1.
   8. Intermediate drive shaft bearing set – Qty 1.

2.14 SOURCE QUALITY CONTROL

A. Source Testing (Factory Acceptance Tests):
   1. As specified in Section 01_75_17 - Commissioning.
   2. Not witnessed.

3. Test as specified in Section 46_05_94 - Mechanical Equipment Testing and the Pump Schedule.
4. Pump casing: Hydrostatic pressure tests if specified in this Section.
5. Furnish test reports and the Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Furnish Manufacturer's Certificate of Installation Verification.

3.02 FIELD QUALITY CONTROL

A. Functional Testing:
   1. Witnessed.
   2. Test as specified in Section 46_05_94 - Mechanical Equipment Testing and the Pump Schedule.
   3. Furnish test reports and the Manufacturer's Certificate of Functional Compliance.

3.03 OWNER TRAINING

A. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   1. Number of sessions:
      a. Operations: One (1) session, two (2) hours minimum.
      b. Maintenance: One (1) session, two (2) hours minimum.

3.04 PUMP SCHEDULE

Tag Numbers	P-34011 and P-34012
General Characteristics	
Service	Return Activated Sludge (RAS)
Quantity	2
Manufacturer's Model and Size	NSYV Model 250 12x12x15
Maximum Noise, dBA at 3 feet	85
Minimum Pumped Fluid degrees Fahrenheit	50
Normal Pumped Fluid degrees Fahrenheit	70
Maximum Pumped Fluid degrees Fahrenheit	85
Pump Characteristics	
Impeller Type	Enclosed, mixed flow
Impeller, Maximum Number Vanes	2

Tag Numbers	P-34011 and P-34012
Pass Minimum Sphere Size, Inch	4.5
Impeller Bearing Lubrication	Grease
Shaft Seal Type	Dynamic Seal
Coupling Type	Existing Intermediate Shaft Coupled
Speed Control	Existing Variable Frequency Drive
Maximum Pump rpm	880
Minimum Pump rpm	410
Rated Design Point (At Maximum Revolutions per Minute)	
Flow, Gallons per Minute	3,500
Head, Feet	38
Minimum Efficiency, Percent	84
Required Condition 2 (At Maximum Revolutions per Minute)	
Flow, Gallons per Minute	2,000
Head Range, Feet	43 to 48
Minimum Efficiency, Percent	63
Required Condition 3 (At Maximum Revolutions per Minute)	
Flow Range, Gallons per Minute	5,600 to 6,200
Head, Feet	20
Minimum Efficiency, Percent	60
Required Condition 4 (At Reduced Revolutions per Minute)	
Flow, Gallons per Minute	1,200
Head, Feet	10
Other Conditions	
Maximum Shut Off Head, Feet	60
Maximum NPSHr at every Specified Flow, Feet	28
Minimum Suction Static Head, Feet	15
Maximum Suction Static Head, Feet	16
Pump Materials	
Impeller Casing	Cast Iron
Impeller	Nickel cast iron
Impeller Wear Ring	410 Stainless Steel
Casing or Suction Head Wear Ring	410 Stainless Steel
Shaft	Steel, Gr 1045
Shaft Sleeve	420 Hardened Stainless Steel (500 BHN)
Pump Bearing Frame	Cast Iron

Tag Numbers	P-34011 and P-34012
Driver Characteristics	
Driver Type	Existing 50 HP Motor
Source Testing	
Performance Test Level	2
Vibration Test Level	2
Noise Test Level	None
Functional Testing	
Performance Test Level	2
Vibration Test Level	2
Noise Test Level	1

END OF SECTION

SECTION 43_23_58.13

SINGLE-LOBE ROTARY PUMPSGENERAL

1.01 SUMMARY

A. Section includes:
   1. Rotary lobe type positive displacement pump with driver, and features as specified and scheduled in this Section.
   2. Refer to related Specifications for additional requirements.

B. Tag numbers: As specified in the Pump Schedule.

1.02 REFERENCES

A. American Gear Manufacturers Association (AGMA).

B. American National Standards Institute (ANSI).

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   3. A278 - Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F (350°C).
   4. A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   5. A470 - Standard Specification for Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts.
   6. A516 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate and Lower Temperature Service.
   7. D2240 - Standard Test Method for Rubber Property-Durometer Hardness.

D. Hydraulic Institute (HI):
   1. 3.1-3.5 - Rotary Pumps.
   2. 3.6 - Rotary Pump Test.
   3. 9.1-9.5 - Pumps - General Guidelines.

E. National Electrical Manufacturers Association (NEMA).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section have the indicated meaning.
   1. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr) are as defined in HI 3.1-3.5, 3.6, and 9.1-9.5 and as modified in the Specifications.
   2. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric. Average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

C. Rotordynamic analysis.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Letter from pump manufacturer that variable frequency drive was reviewed by the pump manufacturer and determined to be acceptable.

C. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria.
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

D. Commissioning Submittals:
   1. As specified in Section 01_75_17 - Commissioning, including the following:
      a. Manufacturer's representative qualifications.
      b. Certificates:
         1) Requirements as specified in this Section.
      c. Test Plans:
         1) Test requirements as specified in this Section.
      d. Test Reports.
      e. Manufacturer's representatives field notes and data.
      f. Owner Training.

E. Product Submittals:
   1. As specified in Section 01_60_00 - Product Requirements.
   2. Product data.
   3. Shop Drawings.
   4. Manufacturer's instructions.
   5. Calculations:
      a. Torsional analysis.
   6. Schedules.

F. Operation and maintenance manuals:
   1. As specified in Section 01_78_24 - Operation and Maintenance Manuals.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements, Section 46_05_10 - Common Work Results for Mechanical, and the manufacturer's instructions.

1.07 WARRANTY

A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pumps: One of the following, or equal:
   1. Boerger, LLC.
   2. Vogelsang USA, LTD.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Components:
   1. Rotary lobe type positive displacement pumps with convoluted type quad-lobe rotors, motors, seals, couplings, base plates, guards, supports, anchor bolts, taps, lifting eyes, stands, and other items as specified and as required for a complete and operational system.

B. Design requirements:
   1. Pump performance characteristics:
      a. As specified in the Pump Schedule.
      b. Rotordynamic analysis level: As scheduled and as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
         1) Vibration analysis expert: Provide when scheduled.
      c. Performance tolerances shall be the same as the test tolerances specified in Section 46_05_94 - Mechanical Equipment Testing.
      d. Pumps shall be suitable for installation as specified in this Section and as indicated on the Drawings.
   2. Motor characteristics: As specified in the Pump Schedule.

C. Product requirements:
   1. As specified in Section 01_60_00 - Product Requirements and Section 46_05_10 - Common Work Results for Mechanical Equipment.

2.03 MATERIALS

A. General: Materials in the Pump Schedule shall be the type and grade as specified in this Section.

B. Cast iron: ASTM A48, Class 30 minimum.

C. Gray iron casting: ASTM A278, Class 30.

D. Buna-N: Synthetic rubber with a minimum Durometer hardness of 70 in accordance with ASTM D2240 test methods.

E. Steel: ASTM A283, Grade D or ASTM A516 Grade 70.

F. Stainless steel: ASTM A276, Type 316 stainless steel; nickel - chrome - boron coating as scheduled.

G. Carbon steel: ASTM A470.

H. Elastomers shall be Buna-N.

2.04 GENERAL PUMP CONSTRUCTION

A. Type: Industrial, heavy duty, positive displacement, rotary lobe type pumps meeting performance requirements and features as scheduled and as specified.

B. Service: Pumping units shall be designed to convey sludge. Normal solids concentrations will range from 0.9 to 6.0 percent. Other service requirements shall be as scheduled.

C. Equipment shall be designed and built for 24-hour continuous service at the rated design condition without overheating, without cavitation, and without excessive vibration or strain.

D. All working parts of the pumps and motors, such as bearings, wearing rings, shaft, sleeves, etc., shall be standard dimensions built to limit gauges or formed templates, such that parts will be interchangeable between like units and such that the Owner may obtain replacement and repair parts for those furnished in the original machines at any time in the future.

E. Lubrication fittings shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards.

F. Pump shall be capable of temporarily running dry without damage and operate in either direction.

2.05 PUMP CASING

A. Materials:
   1. Pump casing: As scheduled.
   2. Pump top and bottom housing: As scheduled: Minimum 750 Brinell hardness.
   3. Front and end covers: Same as pump casing.
   4. Wear plates: As specified.

B. Top and bottom pump housing: Top and bottom segments of the pump shall be adjustable based on wear up to 6 millimeters. The adjustment shall be accomplished by simply moving stainless steel shims from one hole to the next in the pump housing, allowing for the closing of tolerance around the rotors. This adjustment must be available a minimum of 2 times from factory tolerance.
   1. In lieu of providing adjustable top and bottom segments, manufacturer may provide radial wear plates on the casing walls that utilize the same philosophy as the front and rear wear plates.
   2. Radial wear plates shall be designed to allow the Owner to replace the worn component and bring the radial casing back to factory tolerance.

C. Front cover:
   1. Removable front cover shall be mounted to the pump with 4 individual bolts.
   2. Permit removal of the rotors without disturbing piping, bearings, and mechanical seals.
   3. Machined to accept a reversible wear plate.

D. End cover:
   1. Removable end cover shall be flush with no recesses or dead pockets where solids can accumulate.
   2. Sealed with Buna-N O-ring and provide complete access to the pump chamber without disconnecting pipe work glands or bearings.

E. Wear plates: Constructed of Hardox 500 material, or equal, with a minimum Brinell hardness of 550 and a finished, hardened, reversible surface of 700 Brinell.

F. Port connections: Provide ANSI Class 150 raised face flanges. Connections shall be suitable for field coating as specified in Section 09_96_01 - High-Performance Coatings.

2.06 PUMP ROTORS

A. Materials:
   1. Rotor core: As scheduled.
   2. Rotor (and/or rotor tip) coating: As scheduled.

B. Construction:
   1. Pump shall utilize 2 quad or tri-lobe rotors, which are driven through positive timing gears running in oil.
   2. Rotor cores shall be covered with a rotor coating as scheduled.
   3. Geometry of the rotor core shall be the same as that of the finished rotor.
   4. Rotor vane geometry shall be convoluted to provide pressure-pulse free operation.
   5. Designs with rotor vanes parallel to the shaft centerline will not be accepted.
   6. Convoluted rotor shall be specifically designed for pumping sludge containing organic solids, small inorganic particles, and grit.
   7. Rotors shall be positioned on the shaft by replaceable hardened key ways and secured to the shaft by internal/external expansion clamp sleeves and flush discs requiring no recesses in the end cover.

C. In lieu of providing solid rotors, rotors may be provided with replaceable tips. Rotor, rotor tip, and rotor coating material shall be as specified.

2.07 SHAFTS

A. Materials:
   1. Shaft: As scheduled.
   2. Shaft sleeve, if required: As scheduled.

B. Construction: Pump shafts shall be designed to provide sufficient stiffness to operate without distortion, damaging vibration, or excessive wear throughout the range of operation specified.

2.08 STUFFING BOXES

A. Construction:
   1. A blocking chamber located behind the mechanical seal and in front of the bearing housing lip seal shall be molded into the casting of the pump.
      a. Chamber shall be suitable for oil fill through the top and bottom of the pump.
      b. Chamber will have an external pressurized oil bottle mounted above the pump from the fill nipples to view the status of the mechanical seals.
   2. External oil bottle will be located in view of the operator. Oil-quench shall provide lubrication and cooling of the seal, allow detection of seal failures, and provide a buffer zone to the sealed timing gear. Seal water flush systems are not acceptable.
      a. In lieu of providing an external pressurized oil bottle mounted above the pump, manufacturer may provide a plastic stopper on the chamber that is vented to the atmosphere, which will allow fluid to escape as an indication of seal failure.

B. Shaft seal type: As scheduled.

C. Design of the pump shall allow removal and replacement of the seal via the front cover.
   1. Seal designs that open during rotor replacement are not acceptable.

D. Oil drain gearbox and intermediate chamber shall be easily accessible.
   1. Oil drain under the pump is not acceptable.

2.09 GEAR REDUCERS

A. Gear reducers and couplings shall meet the requirements as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

B. Provide NEMA C face connection between motor and gearbox.

C. Provide helical reduction gears, rated for AGMA Class II service with a 1.5 service factor.

D. Provide oil bath lubrication.

2.10 SUPPORTS, PEDESTALS, AND BASEPLATES

A. Materials: Same as pump casing or ASTM A283 steel, hot-dip galvanized after fabrication and coated as specified in Section 09_96_01 - High-Performance Coatings.

B. Pump, driver, and intermediate bearing support strength: Able to withstand minimum 1.5 times maximum imposed operating loads or imposed seismic loads, whichever is greater.

C. Configuration:
   1. Support pump, gear reducers, and motor on a common structural steel baseplate.

2. Pumping unit shall be furnished in a piggyback arrangement, belt driven with motor overtop of pump.
3. Belt drive shall be as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

D. Anchor bolts: Designed by the pump manufacturer:
1. 3/4-inch minimum diameter.
2. As specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.11 EQUIPMENT GUARDS

A. Provide safety guards as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

2.12 DRIVERS

A. Horsepower:
1. As scheduled.
2. Listed driver horsepower is the minimum to be supplied.
a. Increase driver horsepower if required to prevent driver overload while operating at any point of the supplied pump operating head-flow curve including runout.
b. When scheduled driver is a motor, increase motor horsepower if required to prevent operation in the service factor.
c. Make structural, mechanical, and electrical changes required to accommodate increased horsepower.

B. Motors: Provide motors as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower and as specified in this Section.
1. Revolutions per minute: As scheduled.
2. Enclosure: As scheduled.
3. Electrical characteristics: As scheduled.
4. Efficiency, service factor, insulation, and other motor characteristics: As specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.
5. Motor accessories: As specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower and in this Section.
6. Coordinate motors with the variable frequency drive manufacturer to ensure compatibility between the motor and variable frequency drive.
7. Moisture and temperature switches: as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.

C. Other drivers: As scheduled and as specified in sections listed in the Schedule.

D. Non-reverse ratchets: When scheduled, provide driver with non-reverse ratchets or pin mechanism to prevent reverse rotation of the pump and driver in the event of discharge valve failure.

2.13 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts: Deliver the following for each type or size of pump:
   1. 1 spare rotor set or set of replaceable rotor tips.
   2. 1 set of mechanical seals.
   3. 1 set of O-rings.
   4. 1 set of wear plates (front, back, and radial).

B. Special tools: For each type or size of pump specified, provide 1 set of special tools required for complete assembly or disassembly of the pump system components.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

3.03 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning.

B. Source Testing (Factory Acceptance Tests):
   1. Witnessed, in-person and virtual.
      a. Number of Owner and Engineer representatives in person: TBD.
   2. Furnish test reports and Manufacturer’s Certificate of Source Testing.
   3. Equipment testing:
      a. Pump:
         1) Performance test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
         2) Vibration test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
         3) Noise test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
         4) Pump casing: Hydrostatic pressure tests if specified in this Section.

C. Installation Verification:
   1. Furnish Manufacturer’s Certificate of Installation Verification.

D. Functional Testing:
   1. Equipment testing:
      a. Pump:
         1) Performance test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
         2) Vibration test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
         3) Noise test: Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.

E. Owner Training:
   1. Perform Owner Training as specified in Section 01_75_17 - Commissioning.
   2. Number of sessions:
      a. Operations: One 2-hour session.
      b. Maintenance: One 2-hour session.

3.04 PUMP SCHEDULE

Tag Numbers	P-42001, P- 42002, P-53061, P-53062	P-34033, P-34034
General Characteristics		
Service	Blended Sludge	Waste Activated Sludge
Quantity	4	2
First Named Manufacturer's Model Number	CL390 BLUEline	FL518
Second Named Manufacturer's Model Number	VX186-130Q	VX186
Maximum Noise, dBA at 3 feet	85	85
Minimum Pump Displacement (gal/100 rev)	100	100
Minimum Pumped Fluid, degrees Fahrenheit	50	50
Normal Pumped Fluid, degrees Fahrenheit	70	70
Maximum Pumped Fluid, degrees Fahrenheit	85	85
Normal Solids Concentration, Percent	Design Point 1/3: 5.0 - 6.0 Design Point 2: 0.9 - 1.3	0.6 – 1.5
pH	6 - 8	6 - 8
Rotordynamic Analysis Level	Not Required	Not Required
Vibration Analysis Expert	Not Required	Not Required

Tag Numbers	P-42001, P- 42002, P-53061, P-53062	P-34033, P-34034
Pump Characteristics		
Impeller Type	Positive Displacement, Rotary Lobe	Positive Displacement, Rotary Lobe
Minimum Sphere Size, Inch	1.5	1.5
Shaft Seal Type	Double Mechanical	Double Mechanical
Shaft Seal Material	Silicon Carbide	Silicon Carbide
Coupling Type	Spacer	Spacer
Speed Control	Variable Frequency Drive	Variable Frequency Drive
Maximum Pump rpm	293-364	380
Minimum Pump rpm	88-91	100
Suction Flange Diameter, Inches	6	6
Discharge Flange Diameter, Inches	6	6
Inlet Flange to Outlet Flange Dimension, Inches	As indicated on the Drawings	As indicated on the Drawings
Rated Design Point 1 (Full Speed): Thickened Sludge Condition		
Flow, Gallons per Minute	130	N/A
Head, psi	60	N/A
Rated Design Point 2 (Full Speed): Unthickened Sludge Condition		
Flow, Gallons per Minute	270	440
Head, psi	60	16
Rated Design Point 3: Clogged Condition		
Min Flow, Gallons per Minute	5	N/A
Head, psi	100	N/A
Reduced Speed Point: Thickened Sludge Condition		
Flow, Gallons per Minute	40	N/A
Head, psi	60	N/A
Reduced Speed Point: Unthickened Sludge Condition		
Flow, Gallons per Minute	N/A	150
Head, psi	N/A	0
Normal Operating Range		
Flow, Gallons per Minute	40-270	150 – 250
Head, psi	40	0 – 5

Tag Numbers	P-42001, P- 42002, P-53061, P-53062	P-34033, P-34034
Other Conditions		
Minimum NPSHa at Every Specified Flow, Feet	21	53
Pressure Head for Motor Sizing, psi	Per Rated Design Points.	Per Rated Design Points.
Pump Materials		
Casing	Gray Cast Iron	Gray Cast Iron
Top and Bottom Pump Housing	Gray Cast Iron	Gray Cast Iron
Rotor Core	Gray Cast Iron	Gray Cast Iron
Rotor Coating (including rotor tip coating)	Buna-N	Buna-N
Shaft	Carbon Steel	Carbon Steel
Shaft Sleeve, if required	316 Stainless Steel, Ceramic Coated	316 Stainless Steel, Ceramic Coated
Nuts and Bolts	316 Stainless Steel	316 Stainless Steel
Driver Characteristics		
Driver Type	Motor	Motor
Drive Arrangement	Direct Drive	Gear Reducer
Minimum Driver Horsepower	30	20
Maximum Driver rpm	1,800	1,800
Motor Characteristics (when motor is driver type)		
Inverter Duty Rated	Yes	Yes
Motor Voltage/Phases/Hertz	460/3/60	460/3/60
Enclosure Type	TEFC	TEFC
Winding Temperature Detector per Section 26_05_09 - Low Voltage Motors up to 500 Horsepower	Required	Required
Source Testing		
Test Witnessing	Not Witnessed	Not Witnessed
Performance Test Level	1	1
Vibration Test Level	1	1
Noise Test Level	1	1
Functional Testing		
Performance Test Level	1	1
Vibration Test Level	1	1
Noise Test Level	1	1

END OF SECTION

SECTION 43_25_00.10

SUBMERSIBLE SUMP PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for submersible sump pump systems, including pumps, control panels, and level controls.

B. Tag numbers: As specified in the Pump Schedule.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   3. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

B. Hydraulic Institute (HI):
   1. 9.1-9.5 - Pumps - General Guidelines.
   2. 11.6 - Rotodynamic Submersible Pump Tests.
   3. 14.1-14.2 - Rotodynamic Pumps for Nomenclature and Definitions.
   4. 14.3 - Rotodynamic Pumps for Design and Application.

C. National Electrical Manufacturers Association (NEMA).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section have the indicated meaning.
   1. Allowable operating region (AOR): Region over which the service life of the pump is not seriously compromised by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.
   2. Preferred operating region (POR): Region over which the service life of the pump will not be significantly affected by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.
   3. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 9.1-9.5, 11.6, 14.1-14.2, 14.3, and as modified in this Section.
   4. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

C. Rotordynamic analysis.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures.

B. Delegated Design:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01_81_50 - Design Criteria.
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

C. Commissioning Submittals:
   1. As specified in Section 01_75_17 - Commissioning, including the following:
      a. Manufacturer's representative qualifications.
      b. Certificates:
         1) Requirements as specified in this Section.
      c. Test Plans:
         1) Test requirements as specified in this Section.
      d. Test Reports.
      e. Manufacturer's representatives field notes and data.
      f. Owner Training.

D. Product Submittals:
   1. As specified in Section 01_60_00 - Product Requirements.
   2. Product data.
      a. Include pump curves.
   3. Shop Drawings.
   4. Manufacturer's instructions.
   5. Calculations.
   6. Schedules.

E. Operation and maintenance manuals:
   1. As specified in Section01_78_24 - Operation and Maintenance Manuals.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements, Section 46_05_10 - Common Work Results for Mechanical, and the manufacturer's instructions.

1.07 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements.

B. Factory finish:
   1. Exterior cast iron parts:
      a. Water-thinned industrial enamel.
      b. 3 to 4 mils.
   2. Manufacturer to supply touch-up paint for field use.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. As specified Section 01_81_50 - Design Criteria and in the Pump Schedule.

B. Design working pressure: Minimum 1.5 times shut off pressure.

2.03 SUMP PUMP - NON-CLOG WASTEWATER PUMP

A. Suitable for operation with domestic wastewater sludge with high grit, and high solids content: primary sludge, wasted activated sludge (WAS), or thickened wasted activated sludge (TWAS). Explosion proof motors are not required, but may be supplied to allow models that fit the tight space of existing 3-ft diameter sumps.

B. Manufacturers: One of the following or equal:
   1. HOMA, model AMS334-190 7.5TC FM.
   2. Barnes, model 3SHMPA50N4.

C. Housing:
   1. Cast iron: In accordance with ASTM A48, Class 30 or better.
   2. 3-inch NPT vertical discharge connection.
   3. External mating parts shall be machined and Buna-N, O-ring sealed.
   4. Fasteners exposed to the pumped liquid: Type 316 stainless steel.

D. Impeller:
   1. Cast iron: In accordance with ASTM A48, Class 20 or better.
   2. Recessed.
   3. Pump-out vanes on backside.
   4. Mechanically locked to shaft.

E. Bearings:
   1. Upper radial and lower thrust bearings required.
   2. Single row, oil lubricated.
   3. Permanently sealed.

F. Shaft seal:
   1. Type 21 mechanical seal:
      a. Silicon Carbon Ceramic/Silicon Carbide Ceramic.
      b. Elastomer:
         1) Buna-N in accordance with ASTM D2000.
      c. Hardware:
         1) Type 316 stainless steel in accordance with ASTM A276.

G. Grinder assembly:
   1. Shredding ring and grinding impeller: Type 440 stainless steel.
      a. Rockwell hardness: 58 to 60.
   2. Grinding impeller: Key driven and bolted to the shaft.
   3. Shredding ring pressed into the casing and secured by Type 316 stainless steel screws.

H. Motor:
   1. Oil-filled, NEMA B with characteristics as scheduled.
      a. 3-phase, 480 volts.
      b. 1.15 service factor.
      c. Seal leak probes.
      d. Heat sensors on winding.
   2. Shaft: Type 16 stainless steel in accordance with ASTM A276.
   3. Thermal overload with automatic reset.
   4. Class B insulation.

I. Cables:
   1. Power:
      a. SOW sized for amp requirements, 16 gauge minimum.
      b. Length to reach connection point (control panel or junction box) indicated on the Drawings plus 15 feet.
   2. Control:
      a. SOW.
      b. Length same as power cable.
   3. Sealed by compression grommet and epoxy potting for wires.

J. Factory inspection and test, each pump:
   1. Visual inspect for imperfections.
   2. Check ground continuity.
   3. High potential test (Hipot).
   4. Air pressure test of housings for motor and volute.
   5. Test run to:
      a. Monitor voltage and current.
   6. Detect excessive noise.

2.04 VENDOR CONTROL PANEL

A. Vendor control panel (VCP) requirements as specified in the Pump Schedule.

B. Construction and components as specified in Section 40_67_01 - Control Systems: Panels, Enclosures, and Panel Components.

C. Electrical components:
    1. Main circuit breaker:
        a. As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
        b. Flange-mounted operator:
            1) Pad-lockable in the off position.
            2) Disconnects all power to the panel.
            3) Interlock with the panel door.
            4) Defeat mechanism.
    2. Motor starter for each pump:
        a. Motor circuit protector circuit breaker.
        b. Full voltage non-reversing magnetic starter.
        c. Thermal or electronic overloads.
    3. Control power transformer:
        a. Primary voltage: 460 VAC, 3-phase, 60 hertz.
        b. Secondary voltages:
            1) Control and status points: 120 volts.
        c. Sized for all panel components plus 10 percent spare capacity.
        d. Primary and secondary fuses.
    4. Control components:
        a. Terminal strips:
            1) For landing all external wiring.
        b. Relays, timers, and other components as required for the specified functionality and remote monitoring connections.
    5. Duplex operation:
        a. Front panel controls:
            1) HAND/OFF/AUTO switch.
            2) LEAD-STANDBY selector switch:
                a) Designates the lead pump automatic operation.
            3) Momentary LOW-LEVEL OVERRIDE pushbutton.
            4) Running pilot light for each pump.
            5) Pump fault pilot light for each pump.
            6) High-High-level alarm.
        b. Remote monitoring and control:
            1) Provide dry relay contact outputs for the following:
                a) Pump fault alarm: Each pump.
                b) Pump run status: Each pump.
                c) High-High Level Alarm.
        c. Operation:
            1) HAND:
                a) Pump is running.
                b) LOW-level activation stops pump:
                    (1) Momentary LOW-LEVEL OVERRIDE pushbutton overrides.
            2) OFF: Pump stops operation and alarm conditions are re-set.
            3) AUTO: Pumps operate automatically in response to level switch signals.
                a) Lead pump starts when HIGH-level switch is activated.
                b) Lead pump stops when LOW-level switch is activated.
                c) When lead pump fault alarm is activated, standby pump becomes the lead pump.
                d) Activation of HIGH-HIGH-level switch activates HIGH-HIGH-level alarm and standby pump becomes the lead pump.

2.05 LEVEL SWITCHES

A. Type: Ball float as specified in Section 40_72_76 - Level Measurement: Switches.

B. Cable length: Equal to sump depth to the VCP plus 15 feet.

2.06 ACCESSORIES

A. Lifting cables:
   1. Material: Type 304 stainless steel.
   2. Attached to balance point of pump.
   3. Suitable for lifting pump from sump.
   4. Extend from pump attachment to hanger.

B. Lifting hangars:
   1. Material: Type 304 stainless steel.
   2. Suitable to provide storage of extra lift cable and electrical cables at wall sump.

2.07 SPARE PARTS AND SPECIAL TOOLS

A. As specified in Section 01_60_00 - Product Requirements.

B. Special tools: For each type or size of pump, provide 1 set.

C. Touch-up paint: 1 pint of finish coating paint.

D. Spare parts:
   1. Mechanical seal set.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. In accordance with the manufacturer’s instructions.

C. Install lifting hanger 3 feet-6 inches above floor.

D. Remove any extra length of power and control cables at connection point (panel, junction box, or receptacle).

E. Repair damaged finish with the manufacturer's supply of touch up paint.

3.03 PUMP SCHEDULE

A. Attributes:

Tag Numbers	P-42010, P-42011	P-53020, P-53021
General Characteristics		
Sump Pump Type	Sludge Storage Building 420 Sump Pump	Solids Handling Building 530 Sump Pump
Rated Performance		
Total Head, feet	47	47
Design Flow, gpm	130	130
Motor		
Maximum, hp	7.5	7.5
Vendor Control Panel		
Enclosure	NEMA 4X - STS 316	NEMA 4X - STS 316
Operation	Duplex	Duplex

END OF SECTION

SECTION 46_05_10

COMMON WORK RESULTS FOR MECHANICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Mechanical equipment requirements for:
      a. Basic design and performance criteria.
      b. Prescriptive requirements for common components.
      c. Installation requirements.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Gear Manufacturers Association (AGMA) Standards.

C. American Petroleum Institute (API):
   1. 682 - Pumps—Shaft Sealing Systems for Centrifugal and Rotary Pumps.

D. ASTM International (ASTM):
   1. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   2. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   3. A320 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
   4. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   5. F594 - Standard Specification for Stainless Steel Nuts.

E. Hydraulic Institute (HI):
   1. 9.6.8 - Guideline for Dynamics of Pumping Machinery.

F. International Concrete Repair Institute (ICRI):
   1. Guideline No. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

G. International Organization for Standardization (ISO):
   1. 21940 - Mechanical Vibration - Rotor Balancing - Part 1: Introduction.

H. National Electrical Manufacturers Association (NEMA):
   1. MG-1 - Motors and Generators.

I. Society for Protective Coatings (SSPC):
   1. SP-1-Solvent Cleaning.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Definitions used in this specification and equipment Submittals for terms related to rotor-dynamic pumps shall be in accordance with HI 9.6.8, Appendix A, as clarified below.
   2. These definitions shall be applied to equipment other than pumps, unless otherwise specified in Technical Sections.
   3. Resonant frequency:
      a. Frequency of a periodic excitation force that is close to the natural frequencies of an object. Also known as critical frequency, critical speed, or resonant speed.
      b. An undamped resonant frequency within the separation margin is always considered harmful under Level 1 analysis.
      c. A resonant frequency that occurs within a separation margin of 15 percent above or below the operating speed range and has a log decrement greater than +0.3 is considered harmful under Level 2 and Level 3 analysis.
   4. Rotordynamic analysis level:
      a. Level of detail required for rotordynamic analysis is indicated in the Technical Sections schedules as None (no analysis required), Analysis Level 1, Analysis Level 2, or Analysis Level 3, which correlate to increasing levels of required detailed equipment design analysis. Analysis Levels 1, 2, and 3 are based on HI 9.6.8.
      b. Where these specifications differ from HI the more stringent shall apply.
   5. Separation margin:
      a. Span of operating speeds within which interference between excitation orders and resonant frequencies indicate the possibility of harmful vibrations.
      b. Separation margin for a specific application extends 15 percent above and 15 percent below the span of operating speed required for the specified performance conditions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Roof coordination.
   1. Show roof penetrations for mechanical equipment on roof drawing Submittal and include mechanical equipment information:
      a. Type.
      b. Size.
      c. Location.
      d. Configuration of penetration and the surround.
      e. Weight.
      f. Anchoring and support details.

1.05 SUBMITTALS

A. Items in this Section are components of equipment or systems specified in other Sections.
   1. Include data for this Section's components with the equipment or system Submittal.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. General:
   1. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries to provide a complete, operable unit.
   2. Manufacturer shall analyze rubber-bearing vertical-column pumps and equipment identified as non-reversing in the Technical Sections for reverse rotation and provide non reversing motor ratchets.
   3. Equipment that prevents reverse rotation shall be capable of both:
      a. Handling 150 percent of the maximum torque at maximum operating speed.
      b. 150 percent of torque that will be generated in reverse direction due to equipment shutoff head as calculated by the manufacturer.
   4. Motor shall be designed to run safely in the reverse direction at up to 140 percent times the reverse runaway speed under shutoff head conditions.

B. Rotordynamic analysis and vibration testing:
   1. Submit information for the rotordynamic analysis level specified for each piece of equipment as shown in the Technical Sections prior to manufacture of the equipment.
   2. Rotordynamic analysis shall be performed on "like-new" and "as-worn" conditions, representing conditions when first installed and conditions when parts wear to the manufacturer's maximum allowable operating tolerances.
      a. Conditions assumed for the "as-worn" condition shall be 2 times the "like-new" tolerances unless specified otherwise.
   3. Rotordynamic analysis criteria:
      a. Torsional excitation forcing function magnitudes shall be no less than 1 percent of the maximum transmitted torque at given speed.
      b. Motor mass elastic information in accordance with NEMA MG-1 shall be obtained from the original equipment manufacturer and included in the analysis. Motors shall be precision balanced to ISO 21940 Grade G2.5.
      c. Bearings:
         1) At maximum bearing loads an L-10 life of 100,000 hours in accordance with ABMA 9-11 to be proven.
   4. Submit factory and field testing requirements as specified in the Technical Sections and specified in Section 46_05_94 - Mechanical Equipment Testing after manufacture and installation respectively.

5. Repair, replace, and modify equipment exhibiting vibration performance that does not meet criteria specified in this Section at no additional cost to the Owner.
    a. Acceptable remedies include adjustments to equipment component geometry, materials, energy absorbing couplings, etc.
    b. Locking out speed interval(s) within equipment specified operating range is unacceptable.
6. Vibration analysis expert:
    a. Provide when specified in the equipment Technical Sections.
        1) Must be a 3rd party, unaffiliated with the equipment vendor or Contractor.
    b. Analysis shall be provided by one of the following or equal:
        1) Engineering Dynamics Inc. (EDI, Texas).
        2) Mechanical Solutions, Inc. (MSI, New Jersey).
    c. Analysis shall be:
        1) Stamped by a registered professional mechanical engineer.
        2) Verified in-situ by the vibration analysis expert, including certification that installation conforms to field conditions assumed in the reports.
        3) Verified in-situ by the vibration analysis expert, including witness of at least 1 field vibration test, and certification that vibration measurements corroborate the rotordynamic analysis.
        4) Supplemented with additional field investigation and analysis should conditions during field vibration testing activity indicate non-compliance with these specifications; supplemental field investigation and analysis shall indicate remedies to comply with the specifications and shall be stamped by a registered professional mechanical engineer.
7. Rotordynamic Analysis Level 1:
    a. Before the equipment is released for manufacture it shall be determined that the equipment/motor structures do not have any harmful resonant frequencies in the lateral and torsional modes. Representative analysis results for identical equipment may be submitted.
    b. Calculate rotor lateral and torsional and equipment structural components' lateral frequencies with a spreadsheet calculation or finite element analysis software.
        1) Equipment structure lateral frequency shall include the motor.
        2) Speed changing drive systems (belt, gear) effects on rotational inertia and stiffness shall be incorporated.
    c. Determine the equipment system components (rotor and structure) resonant frequencies.
    d. An intersection of an equipment component resonant frequency with the 1x run speed excitation order that occurs within separation margin is unacceptable.
8. Rotordynamic Analysis Level 2:
    a. Before the equipment and motor are released for manufacture it shall be determined that the equipment/motor structures do not have any harmful critical speeds in the lateral and torsional modes.
    b. Calculate rotor lateral and torsional and structure lateral frequencies with finite element analysis software.
        1) Equipment structure lateral frequency shall include the motor.

2) Speed changing drive systems (belt, gear) effects on rotational inertia and stiffness shall be incorporated.
3) Rotational inertia of water within the impeller, in the wet well, and inside the equipment structure, e.g., the column of a vertical pump, shall be included in the calculation at both the high level and low level conditions.

c. Potentially harmful critical speeds shall be investigated further with a forced, damped analysis to determine component stresses do not exceed material properties.

d. Forced damped analysis:
1) Forced lateral analysis shall include forcing function magnitudes at least 10 percent of rotor disc weight at each disc position and hydraulic imbalance at 5 operating conditions spaced equally over the equipment operating range. If synchronous motors are used ensure that the rotor analysis includes startup, shutdown, and motor control transients.
2) Forced torsional analysis shall include not less than 1 percent of the maximum permitted torque at any given speed. Damping shall be 1 percent of critical at all shaft elements.
3) Equipment rotor total stress (steady-state and alternating torque components plus lateral-bending stresses) shall not exceed:
a) Constant torque: Total stress limited to 30 percent of the material fatigue limit and to a maximum of 18 percent of ultimate tensile strength.
b) Variable torque (including variable speed equipment): Total stress limited to 50 percent of the material fatigue limit and to a maximum of 4 percent of the material ultimate tensile strength.
c) Submit documentation of material fatigue limit.

e. Report Submittals:
1) Confirmation of compliance with this Section, or detailed exceptions taken.
2) Software used for analysis.
3) Results with interpretation.
4) Preparer’s professional engineering stamp and seal.
5) Input data, including component properties, materials and connectivity to other components.
6) Schematic diagram of model mode shapes, nodes and elements.
7) Bearing stiffness and damping properties, impeller/diffuser interaction coefficients, and seal dynamic properties.
8) Campbell diagrams showing the system natural frequencies, excitation orders, and operating speed range for both lateral and torsional analysis.
a) Include equipment operating range; excitation lines at 1x, 2x run speed, and vane pass (or equivalent); and critical speeds associated with equipment system components, including the rotor, each major equipment structural component and the motor.
9) Forced, damped analysis indicating acceptable material stress limits are maintained at interference points shown on the Campbell diagram.

9. Rotordynamic Analysis Level 3:
    a. Before the equipment and motor are released for manufacture it shall be determined that the equipment/motor structures do not have any harmful critical speeds in the lateral and torsional modes.
    b. Calculate rotor lateral and torsional and structure lateral frequencies with finite element analysis software.
        1) Equipment structure lateral frequency shall include the motor.
        2) Speed changing drive systems (belt, gear) effects on rotational inertia and stiffness shall be incorporated.
        3) Rotational inertia of water within the impeller, in the wet well, and inside the equipment structure, e.g., the column of a vertical pump, shall be included in the calculation at both the high level and low level conditions.
    c. Potentially harmful critical speeds shall be investigated further with a forced, damped analysis to determine component stresses do not exceed material properties.
    d. Forced damped analysis:
        1) Forced lateral analysis shall include forcing function magnitudes at least 10 percent of rotor disc weight at each disc position and hydraulic imbalance at 5 operating conditions spaced equally over the equipment operating range. If synchronous motors are used ensure that the rotor analysis includes startup, shutdown, and motor control transients.
        2) Forced torsional analysis shall include 1 percent of the maximum permitted torque at any given speed. Damping shall be 1 percent of critical at all shaft elements.
        3) Equipment rotor total stress (steady-state and alternating torque components plus lateral-bending stresses) shall not exceed:
            a) Constant torque: Total stress limited to 30 percent of the material fatigue limit and to a maximum of 18 percent of ultimate tensile strength.
            b) Variable torque (including variable speed equipment): Total stress limited to 50 percent of the material fatigue limit and to a maximum of 4 percent of the material ultimate tensile strength.
            c) Submit documentation of material fatigue limit.
    e. Report Submittals:
        1) Report 1: Executive Summary, including:
            a) Confirmation of compliance with this Section, or detailed exceptions taken.
            b) Software used for analysis.
            c) Results with interpretation.
            d) Preparer’s professional engineering stamp and seal.
            e) Campbell diagrams showing the system natural frequencies, excitation orders, and operating speed range for both lateral and torsional analysis.
                (1) Include equipment operating range; excitation lines at 1x, 2x run speed, vane pass (or equivalent), line- and twice-line frequency, motor-pole frequency, torsional harmonics from reciprocating drivers (including up to 6 times operating speed), control pulse frequencies induced by variable frequency drives (VFD) (with certification from VFD

manufacturer of frequencies up to 24 times motor running speed), any torque harmonic greater than 1 percent of steady torque at primary excitation, and synchronous motor requirements; and critical speeds associated with equipment system components, including the rotor and each major equipment structural component.

f) Report 1 shall not include detailed analysis elements listed for Submittal under Report 2 below, Submittal of full analysis details in Report 1 is unacceptable.

g) Following Submittal of Report 1, submit Report 2: Detailed Analysis, including responses to comments made on Report 1: Rotor-dynamic Executive Summary.

2) Report 2: Rotor-dynamic detailed analysis, including:

a) Input data, including component properties, materials and connectivity to other components.

b) Schematic diagram of model mode shapes, nodes and elements.

c) Bearing stiffness and damping properties, impeller/diffuser interaction coefficients, and seal dynamic properties.

d) Forced, damped analysis indicating acceptable material stress limits are maintained at interference points shown on the Campbell diagram.

e) Synchronous motor information, including time-integration study results showing transient peak stresses at startup, shutdown and motor control transient events. Provide tomographic diagrams, including root and keyway stress concentration locations and the corresponding speeds that result in reported peak stresses.

2.02 POWER TRANSMISSION SYSTEMS

A. V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, VFDs, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints:

1. Rated for 24 hour-a-day continuous service, or for intermittent service with frequent stops-and-starts, whichever is most severe.
2. Sized with a service factor of 1.5 or greater:
    a. Apply service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
    b. Apply service factors in accordance with AGMA, or as specified in the Technical Sections.

2.03 BEARINGS

A. Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.

1. Design lubrication system based on the equipment location to operate in the temperatures as specified in Section 01_81_50 - Design Criteria.
    a. To safely start after being shut off for 24 hours and operate safely:
        1) Suitable for the outdoor winter temperature as specified in Section 01_81_50 - Design Criteria.

B. Oil-lubricated:
   1. Provide either pressure lubricating system or separate oil reservoir splash-type system as specified in the Technical Section.
   2. Design system to safely absorb heat energy generated in bearings when equipment is operating in the following conditions:
      a. With the highest load and the temperature 15 degrees Fahrenheit above the outdoor summer temperature as specified in Section 01_81_50 - Design Criteria.

C. Grease lubricated, except those specified to be factory sealed:
   1. Fit with easily accessible grease supply, flush, drain, and relief fittings.
   2. Lubrication lines and fittings:
      a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
      b. Multiple fitting assemblies: Mount fittings together in easily accessible location.
      c. Use standard hydraulic-type grease supply fittings:
         1) Manufacturers: One of the following or equal:
            a) Alemite.
            b) Zerk.

D. Ratings: In accordance with ABMA 9 or ABMA 11 L10 life for bearings rating life of not less than 50,000 hours.

2.04 BELT DRIVES

A. Sheaves:
   1. Separately mounted on bushings by means of at least 3 pull-up bolts or cap tightening screws.
   2. When 2 sheave sizes are specified, provide separate belts sized for each set of sheaves.
   3. Statically balanced for all; dynamically balanced for sheaves that operate at a peripheral speed of more than 5,500 feet per minute.
   4. Key bushings to drive shaft.

B. Belts:
   1. Anti-static type when explosion-proof equipment or environment is specified.
   2. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit:
      a. Where 2 or more belts are involved, furnish matched sets.
      b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
      c. Package in boxes labeled with identification of contents.

C. Manufacturers: One of the following or equal:
   1. Dodge, Dyna-V belts with matching Dyna-V sheaves and Taper-Lock bushings.
   2. T.B. Woods, Ultra-V belts with matching Sure-Grip sheaves and Sure-Grip bushings.

2.05 FLANGED PIPING CONNECTIONS

A. Unless specified otherwise in the Technical Sections or indicated on the Drawings, provide flat face flanges.

2.06 ASSEMBLY FASTENERS

A. General service: Stainless steel, Type 316:
   1. Bolts: In accordance with ASTM F593, Alloy Group 2.
   2. Nuts: In accordance with ASTM F594, Alloy Group 2.
   3. Washers: Alloy group matching bolts and nuts.

B. High-temperature service or high-pressure service: Stainless steel, Type 316:
   1. Bolts: In accordance with ASTM A193, Grade B8M, Class 1, heavy hex.
   2. Nuts: In accordance with ASTM A194, Grade 8, heavy hex.
   3. Washers: Alloy group matching bolts and nuts.

C. Low-temperature service: Stainless steel, Type 316:
   1. Bolts: In accordance with ASTM A320, Grade B8M, Class 1, heavy hex.
   2. Nuts: In accordance with ASTM A194, Grade B8M, heavy hex.
   3. Washers: Alloy group matching bolts and nuts.

2.07 GUARDS AT HIGH-TEMPERATURE SURFACES

A. Exposed surfaces having an external surface temperature of 120 degrees Fahrenheit or higher and located within 7 feet, measured vertically from floor or working level, or within 15 inches measured horizontally from stairways, ramps, or fixed ladders.

B. Cover with a thermal insulating material unless otherwise guarded against contact.
   1. Insulation thickness such that the insulation exterior temperature is below 120 degrees Fahrenheit.
   2. Insulation Type 3 and cover Type 5 as specified in Section 40_05_06.55 - Piping Insulation.

2.08 GUARDS AT MOVING COMPONENTS

A. On rotating components that are within 7.5 vertical feet of an operating floor or platform.

B. Allow visual inspection of moving parts without removal.

C. Allow access to lubrication fittings.

D. Easily removable for maintenance.

E. Prevent entrance of rain or dripping water for outdoor locations.

F. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of 1 belt.

G. Materials:
   1. Sheet metal: Carbon steel, 12-gauge minimum thickness, hot-dip galvanized after fabrication.
   2. Fasteners: Type 316 stainless steel.

2.09 SHOP FINISHES

A. Manufacturer's standard primer and finish coatings.
   1. Primer only if field coatings are to be applied.

2.10 GEAR MOTORS

A. Parallel shaft drives: Helical gearing.

B. Right-angle drives: Worm gearing.

C. Manufacturers: One of the following or equal:
   1. Baldor Electric Company.
   2. Bodine Electric Company.

2.11 GEAR REDUCTION UNITS

A. Design and performance criteria:
   1. Gear type:
      a. Helical or herringbone.
   2. AGMA Class II service:
      a. Use more severe service condition when such is recommended by unit's manufacturer.
   3. Cast-iron housing with gears running in oil.
   4. Anti-friction bearings.
   5. Thermal horsepower rating based on maximum horsepower rating of prime mover, not actual load.

2.12 MOUNTING AND LIFTING PROVISIONS FOR EQUIPMENT

A. Equipment bases and base plates:
   1. Provide equipment bases with machined support pads, dowels for alignment for mating of adjacent items, openings for electrical conduits, and openings to facilitate grouting.
   2. Provide jacking screws in bases and supports for equipment and for equipment weighing 500 pounds or more.
   3. Materials:
      a. Match equipment material or steel.
      b. Coating: Match equipment.

B. Steel support frames:
   1. Carbon steel:
      a. At exterior locations and at interior wet or moist locations, provide continuous welds on both sides to close seams and edges between steel members.
      b. Grind closure welds smooth.

C. Lifting lugs or eyes:
    1. Equipment units weighing 50 pounds or more:
        a. Provide with lifting lugs or eyes to allow removal with lifting device.

2.13 NAMEPLATES

A. Fastened to equipment at factory in an accessible and visible location.

B. Metal engraved or stamped with text, holes drilled or punched for fasteners.

C. Material: Aluminum or stainless steel.

D. Fasteners: Number 4 or larger oval head stainless steel screws or drive pins.

E. Text:
    1. Manufacturer's name, equipment model number, equipment serial number, and identification tag number.
    2. Additional items indicated in the Technical Sections.
    3. Indicate the following additional information as applicable:
        a. Maximum and normal rotating speed.
        b. Service class in accordance with applicable standards.
    4. Include for pumps:
        a. Rated total dynamic head in feet of fluid.
        b. Rated flow in gallons per minute.
        c. Impeller, gear, screw, diaphragm, or piston size.
    5. Include for motors:
        a. Drive speed.
        b. Motor horsepower with rated capacity.
    6. Include for gear reduction units:
        a. AGMA class of service.
        b. Service factor.
        c. Input and output speeds.

2.14 PUMP SHAFT COUPLINGS

A. General:
    1. Type and ratings: Non-lubricated designed for not less than 50,000 hours of operating life.
    2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, balance, and type of service.
    3. Suitable for an ambient temperature range between -40 degrees to +200 degrees Fahrenheit.

B. Close-couplings for electric-motor-driven equipment:
    1. Manufacturers: One of the following or equal:
        a. Lovejoy.
        b. T.B. Woods.
    2. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
    3. Manufacture flexible component of coupling from synthetic rubber or urethane.

4. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
5. Do not allow metal-to-metal contact between driver and driven equipment.

C. Flexible couplings for direct connected electric-motor-driven equipment:
1. Manufacturers: One of the following or equal:
a. Rexnord.
b. T.B. Woods.
2. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.
3. Provide flexible connecting element of rubber and reinforcement fibers.
4. Provide service factor of 2.0.
5. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

D. Spacer couplings:
1. Where cartridge-type mechanical seals or non-split seals are specified, provide a spacer-type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment.

2.15 PUMP SEAL CHAMBER AND SEALS

A. Seal chamber (stuffing box):
1. Large enough to retrofit with double mechanical seal.

B. Seal types: Based on the following and as specified in the Technical Section:
1. Type 1: Packing:
a. Provide when specified in the Technical Section for wastewater, non-potable water, and sludge applications:
1) Asbestos free.
2) PTFE (Teflon™) free.
3) Braided graphite.
4) Manufacturers: One of the following or equal:
a) Chesterton, 1400.
b) John Crane.
b. Provide when specified for drinking water service:
1) Asbestos free.
2) Material: Braided PTFE (Teflon™).
3) Manufacturers: One of the following or equal:
a) Chesterton, 1725.
b) John Crane.
c. Design:
1) Packing gland to allow adjustment and repacking without dismantling pump, except to open up stuffing box.
2) Seal chamber (stuffing box) large enough to retrofit with double mechanical seal.
3) Manufacturers: One of the following or equal:
a) Chesterton, 1725.
b) John Crane.

2. Type 2: Mechanical seal, flushing, cartridge, single O-ring.
    a. Manufacturers: One of the following or equal:
        1) Chesterton, S10.
        2) John Crane, 5610 Series.
3. Type 3: Mechanical seal, flushing, cartridge, double O-ring:
    a. Manufacturers: One of the following or equal:
        1) Chesterton, S20.
        2) John Crane, 5620 Series.
4. Type 4: Mechanical seal, flushing, cartridge, double split-ring:
    a. Manufacturers: One of the following or equal:
        1) Chesterton, S20.
        2) John Crane, 5620 Series.
5. Type 5: Mechanical seal, flushing, cartridge, single split-ring:
    a. Manufacturers: One of the following or equal:
        1) Chesterton, 442.
        2) John Crane, 5860.
6. Type 6: Mechanical seal, flushless, cartridge, single split-ring:
    a. Manufacturers: One of the following or equal:
        1) Chesterton, 156.
        2) John Crane, 3740 Series.

C. Mechanical seals, Types 2 to 6:
1. Balanced hydraulically.
2. Spring:
    a. Stationary, out of pumping fluid.
    b. Material as specified in the Technical Section. Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
3. O-ring: Viton™ 747.
4. Gland: Type 316L stainless steel.
5. Set screws: Type 316L stainless steel.
6. Faces: Reaction bonded, silicon carbide/carbon.
7. Minimum differential pressures in either direction: 300 pounds per square inch gauge.
    a. Manufacturers: One of the following or equal:
        1) Chesterton, 1400.
        2) John Crane, equivalent product.
8. Drinking water service:
    a. Asbestos free.
    b. Material: Braided PTFE (Teflon™).
    c. Manufacturers: One of the following or equal:
        1) Chesterton, 1725.
        2) John Crane, equivalent product.

D. Flushing system:
1. Provide flushing connections:
    a. 3/4-inch size.
    b. Provide API 682 seal water plan arrangement as specified in the Technical Section:
        1) Plan 11 - Product stream seal water from discharge thru seal.
        2) Plan 13 - Product stream seal water through seal to suction.
        3) Plan 23 - Closed loop seal water with cooler and pumping ring.

4) Plan 32 - Production seal water discharged to product stream.
5) Plan 54 - Production seal water excluded from product stream.

2.16 SAFETY SIGNS

A. Material, sign size, and text: As specified in Section 10_14_00 - Signage.

2.17 SHIPPING

A. Prior to shipment of equipment:
   1. Bearings (and similar items):
      a. Pack separately or provide other protection during transport.
      b. Greased and lubricated.
   2. Gear boxes:
      a. Oil filled or sprayed with rust preventive protective coating.
   3. Fasteners:
      a. Inspect for proper torques and tightness.

PART 3 EXECUTION

3.01 PRE-INSTALLATION

A. Field measurements:
   1. Prior to Shop Drawings preparation, take measurements and verify dimensions indicated on the Drawings.
   2. Ensure equipment and ancillary appurtenances fit within available space.

B. Sequencing and scheduling:
   1. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.
   2. Equipment anchoring: Obtain anchoring material and setting drawings from equipment manufacturers in adequate time for templates to be constructed and anchors to be cast-in-place.

3.02 LUBRICATION LINES AND FITTINGS

A. Support and protect lines from source to point of use.

B. Fittings:
   1. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
   2. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
   3. For underwater bearings: Bring fittings above water surface and mount on edge of structure above.

3.03 ALIGNMENT OF DRIVERS AND EQUIPMENT

A. Where drive motors or other drivers are connected to driven equipment by flexible coupling, disconnect coupling halves and align driver and equipment after driven equipment has been leveled on its foundation.

B. Comply with procedures of appropriate HI, AGMA standards, alignment tolerances of equipment manufacturers and the following requirements to bring components into angular and parallel alignment:
   1. Maximum total coupling offset (not the per-plane offset): Not to exceed 0.5 mils per inch of coupling length for spacer couplings based on coupling length (not dial separation).
   2. Utilize jacking screws, wedges, or shims as recommended by the equipment manufacturer and as specified in the equipment sections.

C. Use reverse-indicator arrangement dial-type or laser-type alignment indicators:
   1. Mount on the driver/coupling flange and equipment/coupling flange.
   2. Alignment instrumentation accuracy shall be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.

D. Alignment and calculations shall include measurement and allowance for thermal growth, spacer coupling length, indicator separation, and axial spacing tolerances of the coupling.

E. When alignment satisfies most stringent tolerance of system components, grout between base and foundation.
   1. Allow minimum 48 hours for grout to harden.
   2. After grout hardens, remove jacking screws, tighten anchor bolts and other connections, and recheck alignment.
   3. Correct alignment as required.

3.04 EQUIPMENT SUPPORT AND ANCHORING TO STRUCTURES

A. Anchor equipment to structures as indicated on the Drawings and as specified.

B. Obtain final anchor bolt layouts for equipment prior to:
   1. Detailing reinforcement for equipment pads.
   2. Preparation of Shop Drawings for metal structures supporting equipment.

C. Anchor bolt templates:
   1. Provide templates as specified in the Technical Sections.
   2. Use final anchor bolt layout to construct templates for setting anchor bolts.
   3. Make templates:
      a. Rigid, and non-deformable during use.
      b. With longitudinal axes of anchors parallel.
      c. With longitudinal axes of anchors perpendicular to surface supporting the equipment.

4. Templates may be reused for multiple locations of the same equipment only if:
    a. Templates are in “like-new” condition prior to each reuse.
    b. Anchor layout has not been deformed or damaged by previous installation, removal, or handling of templates.
5. Sequence:
    a. Set and support templates prior construction of structures surrounding anchors.
    b. Position anchors in templates to provide designated embedment in supporting structure, with required projection for installation of grout, base plates, and hardware for tightening.
    c. Construct concrete or masonry around anchors using methods that preserve required anchor positions and alignment, and clearances to edges of supports or structures.

D. Anchor adjustment sleeves:
1. Use of adjustment sleeves around anchors:
    a. Is at the option of the Contractor.
    b. Does not relieve the Contractor of obligation to construct and use templates for setting of anchors.
    c. May required increased anchor embedment length to develop the strength of the anchor in the embedded length below the adjustment sleeve.
2. Submittal requirements for anchor adjustment sleeves:
    a. Provide within sufficient time for Engineer approval and not less than 10 working days before setting those items.
    b. Proposed locations of sleeves.
    c. Details and dimensions of sleeves.
    d. Sleeve materials of construction, and coatings.
    e. Information on sleeve filler material and means of filler removal.
    f. Type, details, and dimensions of anchor bolts or anchor rods to be used with sleeves.
    g. Calculations showing development of anchor load capacity below the bottom of the sleeve.
    h. Plan for removal of sleeve fillers, if any.
    i. Plan for placement and consolidation of flowable grout inside sleeves and to a level equal to top of concrete slab or equipment pad surrounding the sleeve.

3.05 GROUTING UNDER EQUIPMENT BASES, BASE PLATES, SOLE PLATES, AND SKIDS

A. General:
1. Comply with the equipment manufacturer’s installation instructions, including:
    a. Tolerances for level.
    b. Tolerances for vertical and horizontal alignment.
    c. Requirements or recommendations for grouting spaces and grout installation.
    d. Recommendations for tightening of equipment anchors after grout has cured.

2. Install equipment over grout as indicated on the Drawings or specified only after:
    a. Equipment is leveled and in proper alignment.
    b. Piping connections are complete and in alignment with no strain transmitted to equipment.
3. Install flowable grout, as specified in Section 03_60_00 - Grouting, placed with forms and head boxes.
    a. Use flowable, non-shrink grout.
    b. Use flowable, non-shrink epoxy grout, only where indicated on the Drawings, where specified in Technical Sections, or when approved in advance by the Engineer.
    c. Grouting with dry-pack materials is not permitted.

B. Prepare equipment bases, base plates, soleplates, and skids for grouting:
1. Concrete equipment bases:
    a. Roughen surface in accordance with ICRI, Guideline No. 310.2R, Surface Preparation Profiles CSP-3 and CSP-4.
    b. Clean roughened concrete surfaces.
2. Base plates, soleplates, and skids:
    a. Clean surfaces in accordance with SSPC-SP-1-Solvent Cleaning, to remove dirt, dust, oil, grease, paint, and other material.

C. Level equipment for grouting:
1. Use removable jack screws, or removable steel wedges and shims to support and level equipment bases, base plates, sole plates, and skids.
    a. Do not use leveling nuts placed on equipment anchors to support or level equipment bases, base plates, sole plates, and skids.
2. Removable jack screws:
    a. Provide number, size, and locations of jack screws required to support and level equipment in accordance with the manufacturer's recommendations.
    b. Drill and tap equipment base plates, sole plates, and skids for jack screws.
    c. Support jack screws on circular steel plates that have been epoxy bonded to the equipment foundation.
        1) Provide plates fabricated from Type 316 stainless steel where edges of support plates will have grout side cover of 3 inches or less in the finished Work.
    d. Make provision for removal of jack screws after grouting:
        1) Prevent grout from bonding to jack screws by wrapping jack screw threads that will be in contact with grout with multiple layers of tape or other material acceptable to the Engineer.
    e. Place and cure grout.
    f. After grout is placed and cured:
        1) Remove jack screws and material used to prevent grout from bonding to jack screws.
        2) Provide jack screws to the Owner for future use.
        3) Fill jack screw holes with grout.
        4) Cure grout as specified.

3. Removable steel wedges and shims:
    a. Use for equipment bases, base plates, sole plates, and skids where it is not practical to use jack screws.
    b. Provide number, size, and locations of wedges and shims required to support and level equipment in accordance with the manufacturer's recommendations.
    c. Make provision for removal of wedges and shims after grouting:
        1) Prevent grout from bonding to wedges and shims by wrapping wedges and shims that contact grout with multiple layers of tape or other material acceptable to the Engineer.
        2) Locate and orient wedges and shims to allow for removal after grouting, and to facilitate placement of grout in the remaining voids.
    d. Place and cure grout.
    e. After grout is placed and cured:
        1) Remove wedges and shims, and material used to prevent grout from bonding to them.
        2) Fill jack screw holes with grout.
        3) Cure grout as specified.

D. Construct grout forms:
1. Provide forms:
    a. Rigid with adequate strength to withstand placement of grout.
    b. With surfaces that will produce a smooth, uniform finish for grout edges exposed in the finished Work.
    c. That allow grout to flow horizontally beyond the perimeter of the equipment base plate a distance not less than the thickness of the grout, and not less than 1 inch.
2. Install forms:
    a. Seal form cracks and joints with elastomeric sealant to make form watertight.
    b. Line form surfaces in contact with grout with polyethylene film, or coat with 2 coats of heavy-duty paste wax.
3. Construct grout "head box" over entire length of one side of form.
    a. Make head box height sufficient to force grout to flow under full dimensions of equipment base and to the surrounding form faces.

E. Pre-grouting procedures:
1. Concrete surfaces receiving flowable, non-shrink grout:
    a. Saturate concrete surface in contact with grout and concrete surfaces extending not less than at least 6 inches beyond limits of grout with clean water for a minimum of 24 hours prior to grouting.
    b. Just prior to grout placement, remove standing water using clean rags or oil-free compressed air. Provide saturated surface dry (SSD) concrete for grout placement.
2. Concrete surfaces receiving flowable, non-shrink epoxy grout:
    a. Do not saturate concrete prior to grout placement.

F. Grout placement and curing:
1. Place and cure grout as specified in Section 03_60_00 - Grouting and in this Section.

2. Grouting:
    a. Keep level of grout in head box above bottom of equipment bases, base plates, sole plates, and skids always to drive flow under base.
    b. Maintain continuous grout flow from head box to opposite sides of forms without trapping air or forming voids.
    c. Vibrate, rod, or chain grout to facilitate grout flow, to consolidate grout, and to remove entrapped air.
3. After grout sets, remove forms and trim grout edges at 45-degree angle from bottom edge of equipment bases, base plates, sole plates, and skids.
4. Cure grout as specified in Section 03_60_00 - Grouting.

G. After grout is cured:
1. Remove jack screws or wedges and shims, and material used to prevent grout from bonding to leveling devices.
2. Fill pockets from removed leveling devices with grout.
3. Cure filled voids as specified in Section 03_60_00 - Grouting.
4. Tighten equipment anchors in accordance with the equipment manufacturer's requirements.

3.06 FIELD FINISHES

A. When touchup or repair is required, apply primer and coating systems as recommended by the equipment manufacturer.

END OF SECTION

SECTION 46_05_94

MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Testing of mechanical equipment and systems.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. S1.4 Specification for Sound Level Meters.

B. Hydraulic Institute (HI).

C. National Institute of Standards and Technology (NIST).

1.03 SUBMITTALS

A. Provide Source Test Plans as specified in Section 01_75_17 - Commissioning.

B. Provide Installation and Functional Testing Plans as specified in Section 01_75_17 - Commissioning.

C. Provide vendor operation and maintenance manual as specified in Section 01_78_24 - Operation and Maintenance Manuals.
   1. Include motor rotor bar pass frequencies for motors larger than 500 horsepower.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Commissioning of equipment as specified in:
   1. This Section.
   2. Section 01_75_17 - Commissioning.
   3. Equipment sections:
      a. If testing requirements are not specified, provide Level 1 Tests.

B. Test and prepare piping as specified in Section 40_05_00.09 - Piping Systems Testing prior to equipment testing.

C. Operation of related existing equipment:
   1. Owner will operate related existing equipment or facilities necessary to accomplish the testing.
   2. Schedule and coordinate testing as required by Section 01_75_17 - Commissioning.

D. Provide necessary test instrumentation that has been calibrated within 1 year from date of test to recognized test standards traceable to the NIST or approved source.
   1. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for tests.
   2. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

E. Test measurement and result accuracy:
   1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments.
      a. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
   2. Do not adjust results of tests for instrumentation accuracy.
      a. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

3.02 VARIABLE SPEED EQUIPMENT TESTS

A. Establish performance over the entire speed range and at the average operating condition.

B. Establish performance curves for the following speeds:
   1. The speed corresponding to the rated maximum capacity.
   2. The speed corresponding to the minimum capacity.
   3. The speed corresponding to the average operating conditions.

3.03 PUMP TESTS, ALL LEVELS OF TESTING

A. Test in accordance with the following:
   1. Applicable HI Standards.
   2. This Section.
   3. Equipment sections.

B. Test tolerances: In accordance with appropriate HI Standards, except the following modified tolerances apply:
   1. From 0 to plus 5 percent of head at the rated design point flow.
   2. From 0 to plus 5 percent of flow at the rated design point head.
   3. No tolerance for head and flow when ranges are specified.
   4. No negative tolerance for the efficiency at the rated design point, and other specified conditions.

5. Use of specified test tolerances shall not result in motor overload while operating at any point on the supplied pump operating head-flow curve, including runout.
6. No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

3.04 DRIVERS TESTS

A. Test motors as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.

B. Test other drivers as specified in the equipment section.

3.05 NOISE REQUIREMENTS AND CONTROL

A. Perform noise tests in conjunction with vibration test analysis.

B. Make measurements in relation to reference pressure of 0.0002 microbar.

C. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.

D. Set sound level meter to slow response.

E. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

3.06 PRESSURE TESTING

A. Hydrostatically pressure test pressure containing parts at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher.

3.07 INSPECTION AND BALANCING

A. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits.

B. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.

C. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

D. Critical speed of rotating equipment:
   1. Satisfy the following:
      a. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment’s maximum operating speed.

b. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
c. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.

E. Vibration tests:
1. Definitions:
a. Root mean square: for pumps operating at speeds greater than 600 rpm, the vibration measurement shall be measured as the overall velocity in inches per second root mean square (RMS).
b. Peak-to-peak displacement: The root means squared average of the peak-to-peak displacement multiplied by the square root of 2.
c. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
d. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
e. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency.
1) Manufacturers: One of the following or equal:
a) Rockwell Automation, Entek Group, "Spike Energy" analysis.
b) CSI, "PeakVue."
f. Rotor bar pass frequency (RBF), for detecting loose rotor bars.
g. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
h. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.
i. Preferred operating range: Manufacturer's defined preferred operating range (POR) for the equipment.
j. Allowable operating range: Manufacturer's defined allowable operating range (AOR) for the equipment.
2. Vibration instrumentation requirements:
a. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12-bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high-frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, data output port, circuitry for integration of acceleration data to velocity or double integration to displacement.
1) Manufacturers: One of the following or equal:
a) Computational Systems Inc., (CSI) Division of Emerson Process Management, Model 2120A, Data Collector/analyzer with applicable analysis software.
b) Pruftechnik, VIBXPERT II.

b. Analyzer settings:
    1) Units: English, inches/second, mils, and gravitational forces.
    2) Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
    3) Sample averages: 4 minimum.
    4) Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
    5) Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
    6) Fast fourier transform windowing: Hanning Window.
    7) High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.
c. Accelerometers:
    1) For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount.
        a) Manufacturers: One of the following or equal:
            (1) Wilcoxon Research, Model 797L.
            (2) PCB, Model 393C.
    2) For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder.
        a) Manufacturers: One of the following or equal:
            (1) Wilcoxon Research, Model 793.
            (2) Entek-IRD Model 943.

3. Accelerometer mounting:
    a. Use magnetic mounting or stud mounting.
    b. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
    c. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.
4. Vibration acceptance criteria:
    a. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.

b. Vibration displacement limits: Unless otherwise specified, equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

Operating Conditions and Application Data	Overall Peak-to-Peak Displacement	
	Field, mils	Factory, mils
Operation within the POR	3.0	4.0
Operation within the AOR	4.0	5.0
Additive value when measurement location is greater than 5 feet above foundation.	2.0	2.0
Additive value for solids-handling pumps	2.0	N/A
Additive value for slurry pumps	2.0	N/A

c. Vibration velocity limits: Unless otherwise specified, equipment operating at speeds greater than 600 revolutions per minute is not to exceed the following peak velocity limits:

HI Pump Type	Horsepower	Field Test	Factory Test
		Overall RMS	Overall RMS
Horizontal Solids Handling Centrifugal Pumps	Below 33 hp	0.25	0.28
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type) Vertical Solids Handling Centrifugal Pumps	Between 33 and 100 hp	0.28	0.31
	100 hp and above	0.31	0.34
	Below 33 hp	0.30	0.33
Vertical Turbine, Mixed Flow, and Propeller Pumps (solids-handling type pumps)	Between 33 and 100 hp	0.32	0.35
	100 hp and above	0.34	0.35
Non-Solids Handling Centrifugal Pumps HI Types BB1, BB2, BB3, BB4, BB5, OH1, OH2, OH3, OH4, OH5, and OH7	Below 268 hp	0.15	0.19
	268 hp and above	0.19	0.22
Vertical Turbine, Mixed Flow, and Propeller Pumps HI Types VS1, VS2, VS3, VS4, VS5, VS6, VS7, and VS8	Below 268 hp	0.13	
	268 hp and above	0.17	
Slurry Pumps		0.25	0.30
Motors		See Applicable Motor Specification	See Applicable Motor Specification

HI Pump Type	Horsepower	Field Test	Factory Test
		Overall RMS	Overall RMS
Gear Reducers, Radial		Not to exceed AGMA 6000-B96 limits	Not to exceed AGMA 6000-B96 limits
Other Reducers, Axial		0.1	N/A

d. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.
e. Additional criteria:
    1) No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.
    2) The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.
    3) For motors, the following shall be cause for rejection:
        a) Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that is more than 40 percent of the peak at rotational frequency.
        b) Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.
        c) Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.
        d) Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.
    4) The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

5. Vibration testing results presentation:
    a. Provide equipment drawing with location and orientation of measurement points indicated.
    b. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
    c. When Vibration Spectra Data required:
        1) Plot peak vibration velocity versus frequency in cycles per minute.
        2) Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label

probable cause of vibration peaks whether in excess of specification limits or not.
3) Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
4) Plot motor spectra on a log amplitude scale versus frequency.
d. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
e. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.08 TESTING LEVELS

A. Level 1 Tests:
1. Level 1 Performance Test:
a. General:
1) For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
2) Operate at rated design load conditions.
3) Confirm that equipment is properly assembled.
4) Confirm the equipment moves or rotates in the proper direction.
5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
b. Pumps:
1) Comply with general performance test requirements as specified in this Section.
2) Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
a) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower or the applicable equipment section.
b) Use actual driver for field tests.
3) Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
2. Level 1 Vibration Test:
a. Test requirement:
1) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
b. Equipment operating condition: Test at specified maximum speed.

3. Level 1 Noise Test:
    a. Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

B. Level 2 Tests:
    1. Level 2 Performance Test:
        a. General:
            1) For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
            2) Operate at rated design load conditions.
            3) Confirm that equipment is properly assembled.
            4) Confirm the equipment moves or rotates in the proper direction.
            5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
            6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
        b. Pumps:
            1) Comply with general performance test requirements as specified in this Section.
            2) Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
                a) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.
                b) Use actual driver for field tests.
            3) Test for flow and head at 2 additional conditions; 1 at 25 percent below the rated flow and 1 at 10 percent above the rated flow.
            4) Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.
    2. Level 2 Vibration Test:
        a. Test requirement:
            1) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
            2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
        b. Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.

c. Natural frequency test of field installed equipment:
1) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears, and supports.
2) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.
3) Perform with equipment and attached piping full of intended service or process fluid.

3. Level 2 Noise Test:
a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.

C. Level 3 Tests:
1. Level 3 Performance Tests:
a. General:
1) For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
3) Confirm that equipment is properly assembled.
4) Confirm the equipment moves or rotates in the proper direction.
5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
7) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure, and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
8) Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.

b. Pumps:
1) Comply with general performance test requirements as specified in this Section.
2) Test 4 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test at full speed.
a) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.
b) Use actual driver for field tests.
3) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes or longer as

necessary to measure required performance, vibration, and noise data at each test condition.

4) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.

5) Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:

a) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.

b) Perform efficiency testing with test fluids at maximum rated speed.

c) Perform priming time testing with test fluids at maximum rated speed.

2. Level 3 Vibration Test:

a. Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.

b. Perform High Frequency Enveloping Analysis for gears and bearings.

1) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.

2) Report results in units of acceleration versus frequency in cycles per minute.

c. Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).

d. Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.

3. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plain view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Tests:

1. Level 4 Performance Test:

a. General:

1) For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.

2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.

3) Confirm that equipment is properly assembled.

4) Confirm the equipment moves or rotates in the proper direction.
5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
7) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings, using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
8) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

b. Pumps:
1) Comply with general performance test requirements as specified in this Section.
2) Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
3) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration, and noise data at each test condition.
4) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.
5) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
6) Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
a) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
b) Perform efficiency testing with test fluids at maximum rated speed.
c) Perform priming time testing with test fluids at maximum rated speed.

2. Level 4 Vibration Test: Same as Level 3 vibration test.
3. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

END OF SECTION

SECTION 46_34_01

INLINE DYNAMIC SLUDGE MIXER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Inline dynamic sludge mixer for optimized polymer mixing with thickened sludge, and accessory items required for a complete and operable system.

B. Tag numbers:
   1. Inline Polymer Mixer: MIX-053012.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 112 - Standard Test Procedure for Polyphase Induction Motors and Generators.

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures and Section 01_60_00 - Product Requirements.

B. Product data:
   1. Motor information:
      a. Graphs of efficiency and power factor from 1/2 to full load.
      b. Factory test reports with test reference standard indicated. Include IEEE 112, Form B.
      c. Load calculations for allowable number of starts per hour.

C. Shop Drawings.

D. Calculations.

E. Installation instructions:
   1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
   2. Provide manufacturer’s installation instructions.

F. Vendor operation and maintenance manuals: As specified in Section 01_78_24 - Operation and Maintenance Manuals.

G. Commissioning Submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCT

2.01 MANUFACTURERS

A. Contractor to provide 316ti SST mechanical inline dynamic mixer for sludge and polymer solution mixing. Provide one of the following or equal:
   1. Flocstirr P100 from Aquen Aqua-Engineering GmbH
   2. Dynamic Inline Mixer (DIM) from Huber

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Manufacturer shall provide mechanical inline dynamic mixer for sludge and polymer solution mixing upstream of centrifuge feed. Mixer system shall be designed to allow radial feed of polymer stream into the rotating shaft of the motor. Rotating shaft shall be perforated and allow for polymer to be inserted into the sludge flow. Mixing energy shall vary with mixing speed and flow of sludge and polymer.

B. Design requirements:
   1. Capable of handling thickened blended sludge with Total Solids content up to and including 4-6%.
   2. Able to be easily opened for inspection or service.

C. Performance requirements:
   1. Mixer will be capable of On/Off operation at the Contractor-supplied Local Control Panel (LCP), as well as VFD control at the LCP to optimize polymer usage/mixing with variable thickened sludge inputs as indicated on the Drawings.
   2. Full and complete mixing of polymer with thickened sludge is required within the inline mixing unit.
   3. Mixer speed shall not exceed 3000 rpm.
   4. Mixer motor input power shall be 460-V, 60 Hz, 3-phase.

2.03 INLINE DYNAMIC SLUDGE MIXERS

A. Design:
   1. Inline sludge and polymer solution mixer with motor speed adjustable via variable frequency drive for optimized polymer blending with thickened sludge.
   2. Capable of 220 gpm flowrate through mixing unit.
      Sludge Inlet and outlet shall be no smaller than 4-inches, flanged per ANSI B16.5.

B. Materials:
   1. Major mixer components: Type 316ti stainless steel construction.
   2. Exposed nuts and bolts: Type 316 stainless steel.
   3. Propeller: Type 316ti stainless steel.

C. Jet ring assembly:
   1. Incorporate a jet ring of full 360 degrees around the propeller.
   2. Polymer Connection Size: 3/4-inch
   3. Clearance shall be maintained between the propeller tip and the Tee housing the mixer in order to maintain hydraulic efficiency and power consumption.

2.04 MOTOR

A. General:
   1. Multi-pole motor shall be directly connected to the propeller to produce a propeller speed of not more than 3000 revolutions per minute.
   2. Designed for continuous duty, capable of sustaining a maximum of at least 10 evenly spaced starts per hour.

B. Electric motor type:
   1. Electric motors connected for operation on a 460 volt, 3-phase, 60 hertz, alternating current service.
   2. 3 Horse Power

C. Cables:
   1. Oil resistant chloroprene rubber jacketed.
   2. Each unit: Fitted with lifting cable of adequate length and strength to permit raising and lowering the mixer.

D. Motor efficiency and power factor:
   1. Efficiency, Power Factor, Motor Accessories: As specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.

2.05 LOCAL CONTROL PANEL

A. General:
   1. Local Control Panel (LCP) components and construction shall be as specified in Section 40_67_01 - Control Systems: Panels, Enclosures, and Panel Components.
   2. LCP shall be fully functional, wired, and factory tested prior to shipment.
      a. Provide field wiring terminal strips for external connections.
      b. Additional testing requirements as specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.
   3. Provide surge protection on the incoming power feed.
   4. Provide necessary control hardware and components as required for a fully functional and operational installation.
   5. Coordinate VFD with mixer motor starting torque requirements.
   6. Power supply:
      a. 460 VAC, 3-phase, 60 Hz.

B. Enclosures and panel components:
    1. Enclosure:
        a. Rating: NEMA Type 4X.
        b. Material: 316 SST

C. Electrical components:
    1. Main circuit breaker:
        a. As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
        b. Flange-mounted operator:
            1) Pad-lockable in the off position.
            2) Disconnects all power to the panel.
            3) Interlock with the panel door.
            4) Defeat mechanism.
    2. VFD for inline mixer:
        a. Speed of mixer motor unit shall be adjustable while mixer is running by means of a variable frequency drive controller.
        b. Variable speed drive shall be mounted in the control panel and shall be as specified in Section 26_29_24 - Variable Frequency Drives 0.50 - 50 Horsepower.
        c. Provide the following components as specified in Section 26_29_24 - Variable Frequency Drives 0.50 - 50 Horsepower:
            1) Line Reactor.
            2) Load Reactor.
            3) Keypad, door mounted on front of LCP.
            4) Metal oxide varistors.
            5) Conformal coating for VFD.
        d. Coordinate VFD specifications, ratings, and configuration with Inline Dynamic Sludge Mixer manufacturer to ensure VFD complies with the starting torque and running power requirements.
    3. Control power transformer:
        a. Primary voltage: 460 VAC, 3-phase, 60 hertz.
        b. Secondary voltages:
            1) Control and status points: 120 volts.
        c. Sized for all panel components plus 10 percent spare capacity.
        d. Primary and secondary fuses.
    4. Control components:
        a. Terminal strips:
            1) For landing all external wiring.
        b. Relays, timers, and other components as required for the specified functionality and remote monitoring connections.
    5. Front panel controls:
            1) LOCAL/OFF/REMOTE switch.
            2) Potentiometer to modulate mixer speed.
            3) Running pilot light.
            4) Mixer fault pilot light.
        b. Remote monitoring and control:
            1) Provide means to accept a Run command discrete signal from SCADA.
            2) Provide means to accept a 4-20 mA input for the following:
                a) Speed command from SCADA.

3) Provide dry relay contact outputs for the following:
   a) Mixer fault alarm.
   b) Mixer run status.
   c) LOR in REMOTE.
4) Provide a 4-20mA output for speed indication to SCADA.

c. Operation:
   1) LOCAL:
      a) Mixer runs continuously.
      b) Potentiometer modulates mixer speed.
   2) OFF: Mixer stops operation and alarm conditions are re-set.
   3) REMOTE: Mixer operate automatically in response to request from SCADA.
      a) When requested, mixer operates continuously at operator selected speed entered at SCADA.

2.06 FINISHES

A. Factory prime and coat surfaces coming into contact with sewage, other than stainless steel and hot dip galvanized steel, with the manufacturer's standard coating.

2.07 SPARE PARTS

A. Provide 1 set of the following items for each type and size required by the units:
   1. O-rings.
   2. Bearings.
   3. Mechanical seals.
   4. Power cable grommet.
   5. Epoxy coating repair kit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with the manufacturer's instructions and as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.

B. Contractor shall provide and install all necessary conduit and wiring for the mixer system to function and operate per the mixer manufacturers' recommendations.

3.02 COMMISSIONING

A. As specified in Section 01_75_17 - Commissioning, and this Section.
   1. Manufacturer's representative on-site requirements:
      a. Installation: 2 trips, 1-day minimum each trip.
      b. Functional Testing: 2 trips, 2-day minimum each trip.
   2. Training:
      a. Operation and Maintenance: 2 hours per session, 1 sessions.
   3. Process operational period:
      a. As required by the Owner or Contractor.

B. Source Testing:
   1. Manufacturer shall perform Source Testing for each mixer prior to shipment from the factory.
   2. As specified in Section 46_05_94 - Mechanical Equipment Testing.
   3. Test witnessing: Witnessed.
   4. Conduct Level 1 General Equipment Performance Test.
   5. Tests:
      a. Vacuum test each unit to establish sealing integrity.
      b. Momentarily energize to determine correct rotation and current draw prior to immersion.
      c. Run each mixer dry and immersed to determine correct shaft rotation, thrust direction, and power consumption.
      d. After immersion testing, inspect each mixer for oil seepage, water infiltration, insulation defects, and motor resistance (ohms).
   6. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Installation Verification:
   1. Furnish Manufacturer's Certificate of Installation Verification.

D. Functional Testing:
   1. Test witnessing: Witnessed.
   2. Operate mixers for a minimum of 24 hours with the basins full of water.
   3. After completion of 24-hour test, the equipment shall be removed from the tank and inspected by a factory-trained representative for leaks through the seals.
   4. Demonstrate that the mixers are easily placed and removed without draining the tank and that the mixers easily move up and down the mast assembly without binding or crabbing.
   5. Conduct Level 1 General Equipment Performance Test.
   6. Furnish Manufacturer's Certificate of Functional Compliance.

END OF SECTION

SECTION 46_41_10

SURFACE-MOUNTED MIXERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Mixers mounted through reinforced concrete covers of sludge storage tanks for mixing either a blend of thickened primary sludge and thickened waste activated sludge, or a blend of raw primary sludge and waste activated sludge.

B. Equipment tag numbers:
   1. Sludge Storage Tank Mixer No. 1: MIX-44001.
   2. Sludge Storage Tank Mixer No. 2: MIX-44005.

1.02 REFERENCES

A. American Bearing Manufactures Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. National Electric Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

C. ASTM International (ASTM):
   1. A 182 - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   2. A 193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   3. A 194 - Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High Pressure or High Temperature Service, or Both.
   4. A 240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   5. A 269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   6. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
   7. A 312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   8. A 380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   9. A 554 - Standard Specifications for Welded Stainless Steel Mechanical Tubing.
   10. A 774 - Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

11. A 778 - Standard Specifications for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
12. A 790 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe.
13. A 928 - Standard Specification for Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal.
14. A 967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

1.03 DEFINITIONS

A. Continuous operation: 24-hour-per-day operation for design life of not less than 20 years, or 175,200 hours.

B. Intermittent operation: Periodic operation, including starts and stops; including extended periods of time when not in use.

1.04 SUBMITTALS

A. Submit product data and shop drawings, operation and maintenance manuals, and test reports as specified in Section 01_33_00 - Submittals and as detailed in this Section.

B. Product data and shop drawings:
   1. Furnish shop drawings with a cover sheet indicating the drawing number and specification page and number to which referenced, intended use and data summary, outline drawings, cut-away drawings, parts lists, material specification lists, and all information required to substantiate that the proposed equipment meets the specifications.
      a. Shop drawings submittals will not be considered complete if cut-away or assembly drawings with part and material specification lists are not included.
      b. Shop drawings required for the mixer will include:
         1) General arrangement drawings showing the complete mixer assembly, part number, and material list.
         2) Certified anchor bolt layout drawings.
         3) Structural anchorage calculations as specified in Section 05_05_24 - Anchor Systems.
         4) Certified motor data sheets and gear reducers.
         5) Shop primer and coating data.
         6) Control system data, schematics, and wiring diagrams.
   2. Storage and protection of material:
      a. Certification that special shipping and storage containers shall be utilized to protect the material from handling damage.
      b. Packing, shipping, and storage procedures.
   3. Spare parts list.
   4. Qualifications and resume of installer.
   5. Manufacturer's experience and reference list as specified in Quality Assurance.

C. Manufacturer's installation instructions including anchor bolt layouts and details, support details, and other drawings required for proper installation.

D. Reference list: Shall demonstrate experience with the same mixer model type for similar sludge mixing applications. Include the following information as a minimum:
   1. Name and location of installation.
   2. Name and telephone number of the person in direct responsible charge of the equipment.
   3. Month and year the equipment was placed in operation.
   4. Size of equipment.
   5. Number of units installed.
   6. Service: Sludge mixing.

E. Operation and maintenance manuals:
   1. Operation and maintenance manual submittals shall be complete in one comprehensive submittal.
      a. Individual submittals for components of the system will not be accepted for review.
   2. Provide training course outlines prior to final draft of operation and maintenance manual for approval.
   3. Submit operation and maintenance manuals as specified in Section 01_78_24 - Operations and Maintenance Data.
      a. Start-up of the system will not be permitted until operation and maintenance manuals have been submitted and approved by the Engineer.
      b. The submittal shall include the following:
         1) Operation and maintenance instruction bulletins for each equipment item.
         2) Complete parts list.
         3) Schematic and physical wiring diagrams.
         4) Provide project record documents showing as-built dimensions and design information for all supplied parts and equipment.

F. Certificate of Proper Installation: Manufacturer's certification that the equipment was installed in accordance with the manufacturer's instructions, inspected by the manufacturer, serviced with the proper lubricants, and equipped with applicable safety equipment and controls.

G. Technician's qualifications resume: Submit resume of technician to perform Manufacturers Field Service.

1.05 SYSTEM DESCRIPTION

A. Mixer rotation: As indicated in Mixer Schedule.

B. Mixer capacity: As indicated in Mixer Schedule.

C. Common requirements: Provide surface-mounted, non-clogging, vertical shaft, motor-driven mixers, accessories, and other items required for a complete and operational system. Each mixer system shall include, but not be limited to, the mixer, gearbox (if applicable), and motor.

1.06 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for the following:
   1. Minimum 10 similar projects with satisfactory performance record.
   2. Minimum 5 municipal wastewater treatment projects with satisfactory performance constructed in the last 5 years.

1.07 PROJECT CONDITIONS

A. Environmental project conditions:
   1. Exposed to weather. Temperatures vary between 0 degrees F and 122 degrees F.
   2. Exposed to wastewater containing bacteria, algae, rags, hair, foreign debris, oil/grease, and various chemicals.
   3. Mixers will be designed to completely mix sludge with a total solids content up to 6% Total Solids (TS).

1.08 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements and Section 01_78_36 - Warranties and Bonds.

B. Preparation for shipment:
   1. All materials shall be suitably packaged and braced to protect against damage during transit, handling, and unloading.
   2. Manufacturer shall package equipment, be responsible for, and make good, any and all damage until the equipment is delivered to the job site.
   3. Pack accessories separately in containers clearly marked “ACCESSORIES ONLY.”
   4. Place a packing list, listing the contents of each container, in a moisture-proof envelope and securely fastened to the outside of the container.
   5. Provide written storage procedures for all equipment.

C. Delivery to job site: Fabricate and deliver materials to the job site in conformance with the Contractor’s construction schedule to minimize handling and on-site storage of equipment.

D. Storage and protection:
   1. Protect the system components at the site and during installation prior to project completion.
   2. As a minimum, provide cover, ventilation, and proper stacking to prevent warping of any equipment stored on-site.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work with work sequence specified in Section 01_14_00 - Work Restrictions.

1.10 WARRANTY

A. As specified as Section 01_78_36 - Warranties and Bonds.

1.11 MAINTENANCE

A. Spare parts: Furnish the following spare parts suitably packaged and marked. Include a price list and name, address, and telephone number of local supplier:
   1. One complete set of bearings for each motor, if applicable.
   2. One set of rubber buffers per installed mixer type.
   3. One shaft holder for each shaft diameter supplied.
   4. All lubricating oils required for the first year of operation shall be provided. The products supplied shall be factory prefilled, in accordance with manufacturer's recommendations.
   5. Spare parts shall be identical to and interchangeable with similar parts installed.

B. Special tools: Provide the following special tools:
   1. Tools required to assemble, dissemble, repair, and maintain equipment, and that have been specifically made for use on the equipment.
   2. Necessary eyebolts, hooks, and rods for handling equipment parts.
   3. List of tools with the maintenance and operation data describing the uses of the tools.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Surface-mounted mixers. One of the following, no equal:
   1. Invent Environmental Technologies, Inc. - HYPERCLASSIC®-Mixer.
      a. Contractor to coordinate with Manufacturer for flushed bottom busing as needed in slope of sludge storage tank sump.
   2. Philadelphia Mixing Solutions (SPX FLOW) - Raven 3855M-S.

B. Mixers shall be furnished by a single manufacturer who is fully experienced in the design and manufacture of such equipment.

2.02 SURFACE-MOUNTED MIXERS

A. Type:
   1. Surface-mounted, non-clogging, vertical shaft, motor-driven type, specifically intended for use in wastewater applications.
   2. Design the mixer and its appurtenances specifically for continuous duty operation in a submerged application in a sludge storage tank. The mixers shall not overload the motors at any point within the operating limits recommended by the mixer manufacturer.
   3. Mount the motor on the top of sludge holding tank in a dry installation.
   4. Mixers with Class 1 Division 2 rated motors, submerged bearings other than specified, sleeves, and wear rings, or that rely on motor bearings to take loads will not be acceptable.

2.03 PERFORMANCE REQUIREMENTS

A. Provide mixers with the capability to produce a uniform sludge concentration at all locations within the zones in which they are installed. Mixers that could lead to accumulation of solids in the zone will not be accepted. The Engineer shall design the mixing zone to ensure that inlet flow faces away from the mixer and mixer shaft. On-site testing will be conducted in the presence of the Engineer and the Owner per Article 3.04. If additional mixing capacity is required to meet the performance test requirements, the Contractor is responsible for providing the necessary equipment at no additional cost to the Owner.

2.04 COMPONENTS

A. General:
   1. Provide each mixer assembly with a dry-installed heavy-duty speed reducer with hollow shaft, Class 1 Division 2 rated electric motor, baseplate, and vertical shaft, and a flushed bottom bushing to stabilize the mixer shaft at the base (if required by Manufacturer). Two mixer body styles are acceptable:
      a. Hyperboloid-type.
      b. Impeller-type with backswept, non-clog blades.
   2. Provide each mixer with the capability to handle either a blend of thickened primary sludge and thickened waste activated sludge, or a blend of raw primary sludge and waste activated sludge. Mixers must be capable of mixing blended sludge will a total suspended solids concentration per the mixer schedule listed herein and a design that prevents settlement in the tanks and re-suspends biological material on the tank bottom.
   3. Design the mixer as a vertical shaft mixer, with a dry installed motor. During operation, the mixer shall not generate any upward forces on the bridge construction.
   4. Design the mixer with a steady, stationary flow pointed downward parallel to the mixer shaft. The highest speeds and turbulent fluctuations should be produced in the bottom area.

B. Gear Drive:
   1. Provide the gear drive assembly for each mixer with a parallel-shaft helical gear box and motor as designed by SEW Eurodrive or approved equal.
   2. Totally enclosed, fan cooled 230/460-volt, 60 cycle, 3-phase motor; rated for 50 degrees Centigrade ambient; maximum nominal 1,800 revolutions per minute motor speed; and the following:
      a. Insulation: Class F insulation.
      b. Service factor: 1.0.
      c. Motor junction box with stainless steel relief grip that protects cable to motor connection.
      d. Bearings: Bearings with common lubrication type and frequency requirements, and with minimum B-10 life of 100,000 hours in accordance with ABMA.
      e. Provide a high-quality corrosion protection coating on the gear drive assembly, robust weather protective hood, and bimetallic switches for thermal protection of the motor.

f. Furnish a cast iron gear box housing covered with an acrylic coating, having a thickness of at least 6.0 mil. Connect the gear box to the mounting base using a flange connection with additional 316 stainless steel nuts and bolts.
g. Cover the hollow shaft and seal with a special hollow shaft cap.

3. Motor Protection:

C. Motor accessories as specified in Section 26_05_09 Low Voltage Motors Up To 500 Horsepower. Shaft:
1. Construct drive shafts with material scheduled in Article 3.06.
2. Provide a tappet at the top end of the mixer shaft for the connection to the gear hollow shaft.
3. Provide a flange connection at the lower end between the shaft and the mixer body.

D. Mixer body
1. Hyperboloid-type:
a. Manufacture each hyperboloid mixer body of FRP with a streamlined stress-free body without any mounted or fitted parts.
b. Integrate the transport ribs, which accelerate the flow, into the mixer body.
c. Coat the mixer body with a custom gel coat to provide a polished surface.
d. Furnish laminated stainless steel insert nuts for the hyperboloid body.
e. The bottom of the hyperbolic mixing body should not exceed 12 inches above the basin floor or as recommended by the manufacturer.
f. Sludge applications will require a bottom bushing to stabilize the mixer shaft at the base.
2. Impeller-type:
a. Impeller blades shall be welded to the impeller shaft.
b. The maximum combined tensile (Von Mises) stress in any impeller component shall not exceed 20,000 psi under maximum operating loads.
c. The shaft-impeller system design shall be such that its operating speed shall not exceed 77 percent of its first lateral critical speed. The use of stabilizing rings or fins will not change this limitation.
d. Impeller blades shall be designed with a swept profile to prevent the accumulation of rags anywhere on the impeller leading edges.

E. Mounting Base:
1. Provide the mounting base for each mixer with a gear base plate mounted in rubber buffers connected permanently to the tank structure/supports by bolted connection. The plate shall be able to be leveled using the threaded bolts, which can be adjusted in height.
2. The rubber buffers shall absorb start-up torque, prevent any transfer of vibrations to the bridge, and constitute the galvanic separation of the mixer from its surroundings (if applicable).
3. Include odor seal that works with the mounting base, or mounting flange configuration provided.
4. Include with the mounting base a fastening set for the tank structure with bolted connections. Coordinate bolt locations with Contractor. Final dimensions of mixer pedestal must be coordinated by Contractor with selected manufacturer during construction.

F. Mixer Support on Impeller/Hyperboloid Side:
   1. If required by manufacturer, manufacturer shall provide a bottom bushing support for the mixer on the impeller side, with continuous up-flow flushing.
   2. Construct a minimum 2 feet wide by 2 feet long reinforced concrete column that ties into the bottom slab of the tank and extends to the bottom of the mixer impeller/hyperboloid. Contractor is responsible for the design and construction of the additional reinforced concrete support for mixer and install and coordinate requirements of piping with mixer manufacturer to provide continuous up-flow flushing of the bottom bushing.
   3. Contractor will be responsible to provide structural calculations with drawings sealed and signed by a Professional Engineer registered in the State of Washington for the column and bushing anchorage calculations.

G. Bolts: Type 316 stainless steel; following types:
   1. Assembly bolts.
   2. Anchor bolts for mounting static portions of frame to concrete wall.
   3. Expansion bolts, sized to accommodate mixer static and dynamic loads.
   4. Where Type 316 stainless steel bolts are not feasible, provide high-strength steel bolts to be coated in the field per Section 09_96_01 - High Performance Coatings.

2.05 FINISHES

A. Prime motors, drives, brackets, baseplates with odor seals, and appurtenances with primer, compatible with top coatings as specified in Section 09_96_01 - High-Performance Coatings.

B. Coat machined, polished, and non-ferrous surfaces with corrosion prevention coating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage and conformance to these Specifications.

3.02 INSTALLATION

A. Install equipment specified in strict accordance with the contract documents and requirements of the manufacturer’s written instructions and shop drawings.

B. It is the Contractor’s responsibility to verify the accuracy of all necessary dimensions in the field to ensure compatibility with the specifications and equipment. Provide certificate of proper installation as specified in Section 01_78_36 - Warranties and Bonds.

3.03 FIELD QUALITY CONTROL

A. Manufacturer shall check and approve mixer installation before field operation, verify conformance with Contract requirements, and test operate mixers in presence of Engineer and Owner's on-site representative.

B. Inspection:
   1. Welding:
      a. Prior to installation, all shop fabrication welds will be inspected by Owner's and/or Engineer's on-site representative for crevices, pits, cracks, protrusions, and oxidation deposits.
         1) Presence of any of the aforementioned items in the weld seams is grounds for rejection of the joint.

3.04 START-UP AND TESTING

A. Testing, training, and start-up: As specified in Section 01_75_17 - Commissioning.

B. Performance Test:
   1. Prior to start of the performance tests, fill the zones to the maximum water elevation with test water (plant effluent).
   2. For performance test, operate the mixer for 24 hours.
   3. Demonstrate each mixer:
      a. Is free of overheating of any parts.
      b. Is free of all objectionable vibration, in accordance with manufacturer's recommendations.
      c. Is free of overloading of any parts.

C. Total Suspended Solids (TS) Concentration Test:
   1. Demonstrate that each mixer has been positioned properly and achieves a uniform concentration of total solids at all locations within the basins as specified in the Performance Requirements. Perform test after basin has been filled with sludge.
   2. Test shall be performed with no incoming flow to the basins.
   3. The suspended solids test shall be conducted at or near the design maximum %TS value for the process as specified in Article 3.06. Engineer must approve the %TS for a valid test.
   4. Sample total solids at four selected locations throughout the mixed basins in a vertical stack at various depths as selected by the Engineer.
      a. The maximum depth of any sample is 6 inches above the floor. Collect samples a minimum of 12 inches from any wall.
   5. A uniform concentration of blended sludge shall be defined as 75 percent of the samples being within plus or minus 10 percent of the arithmetic average of the percent TS concentration for all samples taken during the test.
   6. The default resource to test the %TS of collected samples will be the Operators' lab onsite at the treatment plant. However, Contractors may hire a professional lab to do this testing if they desire a third party to perform the %TS tests.

3.05 TRAINING

A. Provide Owner training as specified in Section 01_75_17 - Commissioning.

B. Provide the services of a manufacturer's factory trained representative for a total of 2 trips, each of 3 days to provide start up assistance and instruction on the proper operation of the equipment to the Owner's personnel.

3.06 MIXER SCHEDULE

Tag Numbers	MIX-44001, MIX-44005
General Characteristics	
Service	Sludge Storage Tank
Tank Liquid	Thickened Primary and Secondary Sludge
Type	Mixer
Quantity	2
Rotation Direction	As recommend by manufacturer
Torsional Analysis	Not Required
Design Total Solids (%)	6%
Total Solids (%)	6%
Zone Size:	
Side Water Depth, ft	26
Length, ft	18
Width, ft	18
Mixer Characteristics	
Minimum Mixer Rotations per Minute	25-27
Shaft Material	316 Stainless Steel
Nuts and Bolts / Fastening Hardware	316 Stainless Steel
Hyperboloid-Type Mixer Characteristics	
Mixer Body Material	Fiberglass reinforced plastic
Mixer Body Diameter, inches	90.6
Bottom Bushing to Stabilize Mixer Shaft	Contractor To Coordinate With Manufacturer For Flushed Bottom Busing (If Required)
Blade-Type Mixer Characteristics	
Mixer Body Material	316 Stainless Steel
Maximum Impeller Diameter, inches	132.0
Number of Blades per Mixer Body	3
Bottom Bushing to Stabilize Mixer Shaft	per Manufacturer

Tag Numbers	MIX-44001, MIX-44005
Driver Characteristics	
Driver Classification	Class I Division 2 Group D
Driver Type	Inverter Duty Rated Motor
Speed Control	Variable
Drive Arrangement	Vertical
Maximum Driver Horsepower	10
Max. Driver Speed, rpm	1,800
Motor Characteristics (when motor is driver type)	
Service Factor	1.0
Voltage/Phases/Hz	460/3/60
NEMA Enclosure Type	TEFC
NEMA MG1 Motor Efficiency	Premium
Source Quality Control Testing	
Test Witnessing	Not Witnessed
Performance Test Level	1
Vibration Test Level	1
Field Quality Control Testing	
Performance Test Level	1
Vibration Test Level	1

END OF SECTION

SECTION 46_78_83

PACKAGED BIOTRICKLING FILTER ODOR CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Packaged odor control system utilizing a vertical biotrickling filter for the purpose of removing hydrogen sulfide odors.

B. Equipment tag numbers:
   1. BTF-44020.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.
   2. B73.1 - Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process.
   3. RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. ASTM International (ASTM):
   1. D3299 - Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks.
   2. D3982 - Standard Specification for Contact Molded “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Ducts.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

D. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
   2. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

E. Underwriters Laboratories, Inc. (UL):
   1. 508 - Standard for Industrial Control Equipment.
   2. 508A - Standard for Industrial Control Panels.
   3. 698A - Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
   4. 1449 - Surge Protective Devices.

1.03 DELEGATED DESIGN

A. As specified in Section 01_35_73 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SYSTEM DESCRIPTION

A. The Contractor shall be responsible for providing one fully functioning odor control system.
   1. The odor control system shall utilize a biotrickling filter with synthetic media and water recirculation to optimize H_2S and other odorous compound removal.

B. Equipment for the odor control system shall be provided by one Manufacturer or responsible system supplier, and shall include but not be limited to the following:
   1. Odor Control System:
      a. 1 centrifugal fan.
      b. 1 grease eliminator trap.
      c. 1 biotrickling filter unit.
      d. 1 recirculation pump.
      e. 1 nutrient pump.
      f. 1 55-gallon FRP nutrient reservoir.
      g. One vendor master control panel.
      h. Plant utility water piping, flow meters, valves, and spray and humidification piping inside the vessel. The acclimation system should be integrated, pre-wired, and pre-piped into the irrigation system. The irrigation control components shall be housed in a Stainless Steel NEMA 4X control panel. Water control panels exposed to the elements are not allowed.
      i. Provide maintenance platforms on the biotrickling filter unit allowing access to the spray nozzles.
      j. Associated controls.
      k. Associated fan motor VFDs and starters.
      l. Associated FRP ductwork, expansion joints, appurtenances, and accessories.
      m. Consultation and training to the Contractor to assure a properly installed system.
      n. All interconnecting piping external to the biotrickling filter units and vendor control panels shall be provided and installed by the Contractor.
      o. All interconnecting conduit/wiring external master vendor control panel and all equipment, instruments, and devices associated with the odor control system shall be provided by the Contractor.
      p. All provided equipment to be outdoor and UV rated.

C. The odor control system equipment shall be installed as indicated on the Drawings.

D. The odor control system supplier shall provide media and components suitable for the service conditions listed herein.

E. The odor control system shall be suitable for installation in an NFPA 820 Class I Division 2 Group D hazardous duty location.

F. The odor control system specified herein shall be a portion of a complete odor treatment train. Many portions of the complete odor treatment train including exhaust fans, ductwork and dampers, and instrumentation and controls are specified elsewhere, and are not included in this specification section.

G. The system specified herein, as well as the components specified in Sections 23_31_17 - Fiberglass Reinforced Plastic Ducts, 23_05_00 - Common Work Results for HVAC, and 23_09_13 - Instrumentation and Control Devices for HVAC, shall be supplied by one or more Manufacturers with facilities actively designing and manufacturing fiberglass components for the wastewater industry.

H. Electrical Requirements: Provide all electrical work for complete odor control system installation, including skid equipment interconnections, based on final approved equipment shop drawings.
   1. Provide underslab or exposed conduit for Odor Control System interconnections. Embedded or inslab conduit is not permitted.
   2. See Division 26, Electrical Requirements, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

I. The Contractor shall provide the odor control system as defined in subsection 1.04.A&B from a single responsible supplier. The Supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance requirements, features and functions.

J. The odor control unit, fans, air duct, and water piping shall be constructed of materials that are highly resistant to corrosion and suitable for conditions typically experienced in wastewater treatment plants. Materials shall be resistant to high concentrations of hydrogen sulfide and environments having pH levels below 2 for FRP vessels, fans, and ducting; CPVC for piping as specified herein.

1.05 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures and Section 01_60_00 - Product Requirements.

B. Provide Shop Drawings, Installation Drawings, and Samples as follows:
   1. Detailed Structural and Mechanical Layout Drawings showing system fabrication, dimensions, size, and locations of connections to other work.
   2. Complete design calculations for the media support system, structural members, vessel fabrication, and anchoring shall be performed, signed, and stamped by a Structural Engineer registered in the state where the project is located.
   3. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   4. Manufacturer's Information on the biotrickling filter media, such as:
      a. Pressure drop data through media.
      b. Biofiltration Media Physical Characteristics, including:
         1) Media Volume.
         2) Media Depth.
         3) Residence Time.
         4) Media material
      c. Information on expected settling rates of the media per year.

d. Biotrickling filter pressure drop calculations.
e. Operating data from previous installations to substantiate media performance claims.

5. Piping and instrumentation diagrams: Show piping including manual valves, piping material and pressure break points, local indicators, branch connections, bypasses, equipment and instrumentation in Instrumentation Society of America format; schematic to match actual representation of the process flow through the piping, instrumentation measurement devices and equipment.
6. Control narrative including:
   a. Detailed description of local control operation.
   b. Detailed description of manual control operation through the vendor control panel.
   c. Detailed description of automatic control operation through the PLC interface.
   d. Detailed description of remote control capability through the plant SCADA interface.
   e. Detailed description of all system hardware and software interlocks.
   f. Detailed description of all operator accessible settings and set points.
7. Certified motor data sheets in accordance with Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.
8. Wiring diagrams: Show terminal strips and interconnection of devices.
9. Logic diagrams: Show ladder logic for devices including programmable devices.
10. Dimensioned 3D layout drawings to scale of system showing vessels, equipment, piping, ducting, valves, switches, control units, electrical conduit, and other items.
11. Where 2 or more Manufacturers are concerned in furnishing equipment for a single control system, the Primary Supplier shall provide a coordinated drawing showing how equipment is to be installed and operate together.
12. For fiber reinforced thermoset plastic resin construction, provide details on construction including for every layer the thickness, specific resins used, additives used, catalysts used, type of glass mat or fiber used, layup technique and the details and technique for reinforcing openings.
13. For connections to fiber reinforced thermoset plastic resin or plastic vessel, provide details of the connection type, flanges, backing, bolting, and corrosion protection provided.
14. External utility requirements.
15. Complete instrumentation, control, logic, and power wiring diagrams in sufficient detail to allow installation of the instrumentation, controls, and electrical components.
16. Coating Systems: Including Manufacturer's descriptive technical catalog literature and Specifications.
17. Field-testing plan for meeting system performance requirements.
18. Contractor electrical installation drawings for all control panels, equipment, instruments, and devices associated with Odor Control System. Electrical installation drawings shall be based upon the final approved Manufacturer drawings.

C. Provide Quality Control Submittals as follows:
   1. Operations and Maintenance Data.
   2. Manufacturer's Certification of Compliance that the factory system is identical to the requirements specified herein.
   3. Manufacturer's Certificate of Proper Installation.
   4. Manufacturer's Training Program.
   5. Equipment Performance Testing and Field Startup Report.

D. Product data: Bill of materials and catalog data on all equipment, internals, instrumentation, controllers, relays, switches, and such other accessories as are needed to properly operate the biotrickling filter and the control or metering system.

E. Operations and Maintenance Manuals:
   1. Manuals for items comprising the biotrickling filter systems as specified in Section 01_78_24 - Operation and Maintenance.
   2. Components: Provide information for components; detail as specified in this Section and in Section 46_05_00 - Common Work Results for Mechanical Equipment.

F. Control System Software Record Documents:
   1. Include complete documentation of all the software programs provided for the control system, including:
      a. Listings of all application software on both hard copy and USB flash drive.
      b. Database, both hard copy and USB flash drive.
      c. Communication protocols.
      d. All documentation necessary to maintain, troubleshoot, modify, or update the software system.

G. Closeout submittals.

H. Provide warranty certificates.

1.06 ADMINSTRATIVE REQUIREMENTS

A. Programming coordination:
   1. Coordinate requirements for data transfer with plant control system, PCS:
      a. Include data registers, data types, and engineering units, etc.
   2. Coordinate with the instrumentation and controls subcontractor and ICSC for factory testing.
      a. Vendor shall supply PLC and LOI programming file prior to the testing.
   3. Coordinate data transfer to and from PCS with ICSC at programming meetings as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: The biotrickling filter system Manufacturer/supplier shall be one recognized and established in the design, production, and manufacturing of biological odor control systems. The biotrickling filter system Manufacturer/supplier shall have at least 10 years' experience in design and fabrication of similar systems as demonstrated by a list of at least 5 successful

installations of comparable size (1,000 cfm or greater) at municipal wastewater treatment plants in the United States, which have been in operation for at least 5 years, with at least a 99 percent hydrogen sulfide removal efficiency. References must include valid names and phone contact numbers that can be verified.

1. Provide 3 references for units in the United States, include Owner name, current phone number, and summary design criteria (air cubic feet per minute, inlet and outlet odor concentrations).
2. Testing firm: Provide odor system performance testing firm qualifications.

B. The biotrickling filter system supplier must be able to provide the Owner with training and monitoring support service during the first 2 years of operation.

C. System Responsibility:
   1. Primary supplier: A single vendor:
      a. Responsible for the odor control system which includes a biotrickling filter vessel, vessel internals, packing, liquid distribution, an irrigation pump, demisting section, vendor control panels, instrumentation, fans, nutrient metering pumps, and other components of the package system.
      b. Responsible for furnishing the system as specified herein, for delivery to site, assistance with installation, start-up, testing and for warranty of the system design and performance.
   2. All components of the Section 46_78_83 - Packaged Biotrickling Filter Odor Control System, Section 23_31_17 - Fiberglass Reinforced Plastic Ducts, and Section 23_05_00 - Common Work Results for HVAC, shall be provided by suppliers who have maintained a facility for at least 10 years. The manufacturer of the fiberglass vessel and components is responsible for the single source warranty and process performance responsibility, as well as achieving the standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

D. Site Representative:
   1. Primary supplier is required to have one or more qualified representatives at the site to advise the Contractor in the proper unloading at the site, setting the skids at the site, duct installation, other installation work, connections to other parts of the Work, initial check out, device calibration, pre-start-up testing, control parameter settings, performance testing and correction of problems occurring during this period.

1.08 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01_60_00 - Product Requirements and the manufacturer’s instructions.

1.09 PROJECT OR SITE CONDITIONS

A. As specified in Section 01_81_50 - Design Criteria.

1.10 WARRANTY

A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

B. Special warranty:
   1. Scrubber vessels warranty duration: Provide 10-year warranty for defects in material and resistance to the chemical and ambient environment specified.
   2. Warrant the odor control system, including odor control scrubber and scrubber accessories, FRP fan, ductwork and dampers, chemical storage and feed system from date of acceptance for 2 years.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01_60_00 - Product Requirements.

2.02 MANUFACTURERS

A. Materials, equipment, components, and accessories specified in this Section shall be products of one of the following, or equal approved by Owner prior to end of Bid Period:
   1. Daniel Company
   2. ECS Environmental Solutions

B. Manufacturers/suppliers who wish to be considered equal per 2.01.A.2 must show compliance with subsection 1.07. Manufacturers: One of the following or equal:

2.03 DESIGN AND PERFORMANCE CRITERIA

A. Design the Odor Control system for the following criteria.

Peak Inlet H_2S (ppm)	50
Average Inlet H_2S (ppm)	5
Average H_2S Removal Efficiency	Greater than 99 percent; or less than or equal to 0.5 ppmv, whichever is higher
Total System Airflow Rate (cfm)	1,200
Number of Units	1
Number of Beds	2
Minimum Empty Bed Residence Time(s) per unit	15
Media Height (ft)(each)	4.5
Maximum Pressure Drop Across Unit (in. w.c.) per Unit	2.0
Maximum External Static Pressure upstream of grease eliminator (in. w.c.)	2.0
Maximum Temperature (degrees Fahrenheit)	110
Maximum vessel dimensions (each unit) (base to stack)	6-foot diameter, 20 feet high

B. Piping and ducting:
   1. Provide flanged connections for external connections to the system; provide flexible couplings at the connection points.
   2. Support independently from equipment to avoid loads to equipment nozzles.
   3. Isolate loads due to thermal expansion of piping from equipment.
   4. Piping and fittings: Schedule 80 CPVC minimum strength.

C. Electrical and instrumentation:
   1. Area classification: Class 1, Division 2, Group D if within 3 feet of the fan; within any fan enclosure; or within 3 feet of fittings, flanges or other openings in accordance with NFPA 820.
   2. Terminations: Terminate wiring for external control and power connections in junction boxes.
   3. Control system: Fully automatic irrigation and with an integrated acclimation system which incorporates a nutrient feed to maintain microbial population as necessary to maintain removal performance; other requirements as specified elsewhere in this Section.
   4. Meet the component requirements for electrical systems and control systems as specified in the Contract Documents.

2.04 PROCESS DESCRIPTION

A. The odor control process utilizes two layers, consisting of an inorganic porous substrate, to support a thin film sulfur oxidizing bacteria for the removal of H_2S. The system is an up-flow vapor-phase design providing integrated sections:
   1. Nutrient/humidification.
   2. Air distribution.
   3. Inorganic media.
   4. Irrigation/acclimation system.

2.05 BIOTRICKLING FILTER SYSTEM

A. Material of Construction:
   1. The FRP vessel will be manufactured utilizing the helical filament winding method of fabrication in accordance with ASTM D3299, ASTM D4097, and ASME/RTP-1. This method will be used with a winding angle measured about the shell axis of 65-75 degrees. All hand lay-up laminates for nozzles, fittings, and manways will be in accordance with NBS PS 15-69 standards. Any material of construction other than FRP with premium grade vinyl ester resin will not be allowed. Fiberglass reinforced plastic (FRP) fabrication must meet the requirements of this specification and Specification Section 06_80_15 - Fiberglass Reinforced Plastic, whichever is stricter.
   2. Resin used in the system liner shall be a premium fire retardant vinyl ester type such as Dion Impact 9303-54 by Reichhold, Derakane 510 by Dow Chemical, or approved equal. The resin shall be reinforced with an inner veil of a suitable synthetic organic fiber such as Nexus 111-00010.
   3. UV Stabilization: Resin shall be a UV stabilized vinyl ester. Resin may be UV stabilized using Ultraviolet Light Absorbers (UVA) or Hindered Maine Light Stabilizers (HALS), used individually or as blends.
   4. Reinforcement: Glass fiber reinforcement used shall be commercial grade corrosion resistance borosilicate glass.

5. All glass fiber reinforcement shall be Type E electrical grade.
6. Surfacing veil shall be 10 mil Nexus 111-00010 or equal.
7. Mat shall be Type "E" (electrical grade) glass, 1 1/2 oz. per sq. ft with a nominal fiber length of 1.25 ± 0.25 inches, with a silane finish and styrene soluble binder.
8. Continuous glass roving used in chopper gun spray-up applications shall be Type "E" grade with chrome or silane coupling agent.
9. Alternate layers of mat and woven roving used for reinforcement
10. Miscellaneous:
    a. Stainless Steel: Unless otherwise specified, all fasteners, and metal attachments, such as anchors, brackets etc. shall be ANSI 316SS.
    b. Gaskets: Unless otherwise specified, all gaskets shall be EPDM.

B. Fabrication:
1. General: Fabrication shall be in accordance with Section 06_80_15 - Fiberglass Reinforced Plastic and NBS PS 15-69, ASTM D3299 and ASTM D4097. The more stringent requirements shall apply. All non-molded surfaces shall be coated with resin incorporating paraffin to facilitate a full cure of the surface. All cut edges, bolt holes, and secondary bonds shall be sealed with a resin coat prior to the final paraffinated resin coat. All voids to be filled with a resin paste.
2. Corrosion Liner: The inner surface of all laminates shall be resin rich and reinforced with one Nexus 111-00010 with a minimum thickness of 10 mils. The interior corrosion layer shall consist of 2 layers of 1 1/2 oz per sq. ft. chopped strand mat. If the application is by chopper gun spray up the glass fiber shall be 1/2 to 2 in length. The total corrosion liner thickness shall be a minimum of 100 mils and have a resin to glass ratio of 80/20. All edges of reinforcement to be lapped a minimum of one inch.
3. Structural Laminate: Structural laminates shall consist of alternating layers of 1-1/2 oz per sq. ft mat or chopped glass and 24 oz per sq. yard woven roving applied to reach a designed thickness. Actual laminate sequences shall be per the laminate tables shown on fabrication drawings. The exterior surface shall be relatively smooth and shall have no glass fibers exposed. The exterior shall be surface coated with gel coat containing ultraviolet light inhibitors.

C. Media Support System: FRP.
1. Media support plates and grating shall be rated for a minimum of 250 lbs/ft^2, and mid-span supports shall be suitable to support the weight of the media and entrained liquid solution.

D. System Piping:
1. Exterior: Schedule 80 CPVC.
2. Interior: Schedule 80 CPVC.

E. System Ductwork and accessories per Sections 23_31_17 - Fiberglass Reinforced Plastic Ducts and 23_05_00 - Common Work Results for HVAC.
1. The Odor Control System supplier shall supply FRP duct per Section 23_31_17 - Fiberglass Reinforced Plastic Ducts.

F. The vessel shall be equipped with the accessories as listed below:
   1. All necessary access doors, nozzles and other attachments. Vessel connection flanges shall be compatible with connecting piping and ductwork.
   2. At least one side entry manway shall be provided every 5 feet for each lift and spray nozzle assembly with bolted flanged covers and rated for 10-psi minimum. Bolted manways shall be provided with 1/8-inch thick full-face EPDM gaskets with 316 stainless steel bolts. Provide manways as needed for media and nozzle inspection, access to internals, and media replacement for the biotrickling filter and as shown on the plans
   3. All bolts and fasteners shall be Type 316 stainless steel.
   4. All gaskets shall be EPDM.

G. Spray Irrigation/Acclimation System:
   1. The irrigation system shall consist of a uniform spray non-clogging type nozzle assembly above the top media layer.
   2. Nutrient Pump and FRP nutrient reservoir rated for 30 day capacity:
      a. Rated head as required to pump liquid from the bottom nutrient solution tank to the spray nozzles.
      b. The nutrient pump motor shall be sized and selected by the odor control supplier.
      c. Motor shall meet the requirements of Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.

H. Maintenance Platform:
   1. Maintenance platform shall be designed and furnished by the odor control system Manufacturer for accessing the irrigation manway.
   2. The maintenance platforms will be connected and accessed by a single set of stairs supplied by the Contractor.
   3. Railings for the maintenance platforms shall be aluminum.

2.06 MEDIA

A. The media shall be random-dumped, without any carbon, lava rock or expanded clay components. Stacked-type media is not acceptable. Specially configured and/or proprietary media shall not be allowed.

B. The media shall be polyurethane, reticulated foam with a specific surface area of 550 m2/m3. Media shall be installed by contractor and shall be evenly distributed throughout the bed(s). Structured airways within the media are not allowed.

2.07 ACCESSORIES

A. Air inlets, air outlets, spray headers, media support, drains, and all connections whether shown on the Drawings or not shall be provided by the Manufacturer. Tie down lugs shall be integrally molded into the walls of the vessels. All external bolts shall be 316SS and designed for the specified loads. Interior fasteners shall be of corrosion resistant materials such as CPVC or FRP.

B. FRP grease traps are required for the odor control system immediately before each centrifugal fan inlet. Grease traps shall be designed by the odor control Manufacturer and shall not exceed 1.2 inches water column pressure drop at the fan design airflow rates. Provide differential pressure indicating switch with 316 SS tubing across the grease filter and wired to the control panel as specified and shown on the Drawings.

C. Neoprene Pad: A 1/4-inch thick neoprene sheet must be placed underneath the biotrickling filter vessel.

D. One water control panel shall be provided for the biotrickling filter unit. The control cabinet shall be 316 Stainless Steel NEMA 4X construction. The cabinet shall be mounted on two stainless steel Unistrut columns anchored to the concrete slab. The cabinet shall contain the following components:
   1. Make-up water pressure reducing valve.
   2. Make-up water solenoid flush valve.
   3. Make-up water rotameter.
   4. Recirculation line magnetic flow meter.
   5. Recirculation line flow switch.
   6. Recirculation line flow control valve.
   7. Recirculation line sample port with valve.
   8. Recirculation line pH probe.
   9. Basket or wye strainer as shown on the drawings to remain outside of water control panel.

E. Solenoid valves and rotameters shall be provided for control of water application rates. These components shall be sized and selected by the odor control supplier. Provide CPVC diaphragm valves, 316 SS pressure gauges, 316 SS differential pressure gauge across media section, 316 SS solenoid valves, and CPVC pressure regulating valves by Manufacturers listed in the valve Specifications Sections.
   1. Pressure gauges shall meet all requirements of Section 40_73_13 - Pressure/Vacuum Measurement: Gauges and shall be provided for make-up water and recirculation lines.

F. Water Flow Control: The direct-reading rotameter shall be a variable area type with a Teflon® float, EPR O-rings, and CPVC fittings. The rotameter shall be of the same size as the pipe in which it is installed. The rotameter shall have a direct reading scale.

G. Nutrient Addition: Provide a heat-traced and insulated nutrient storage tank and metering system with the biotrickling filter vessel. Nutrients supplied as a coating to the support media shall not be allowed. The injector/eductor systems and piping shall be sized by system supplier. The initial supply of nutrient until after a successful mechanical test and successful performance test results shall be supplied by the odor control supplier.

H. Nutrient reservoir: Provide nutrient storage tank (30-day storage capacity, or 55-gallons, whichever is greater).

2.08 CENTRIFUGAL FANS

A. Fiberglass Reinforced Plastic:
   1. Manufacturers: One of the following or equal:
      a. ICI America, Atlac 711.
      b. Dow Chemical Co., Derakane 510A-40.
      c. Ashland Chemical Co., Hetron 992FR.
   2. Characteristics:
      a. Resistant to corrosion in wastewater treatment plants.
      b. Fire retardant with maximum flame spread of 25 when tested in accordance with ASTM E84.
      c. Inhibits ultraviolet light.
      d. Color as selected by the Engineer. Submit color chart.
   3. Fabrication:
      a. Conceal glass fibers with final gel coat on exterior surfaces.
      b. Apply resin-rich fiberglass reinforced plastic to inner scroll surfaces and other surfaces exposed to air stream without cracks, pits, or waviness.
         1) Ensure that fiberglass reinforced plastic remains smooth for entire fan service life.
      c. Provide synthetic veil on the airstream surfaces.
         1) Veil shall be non-woven polyester-fabric, NEXUS.
      d. Manufacturers: The following or equal:
         1) Burlington Ind.

B. Manufacturers: One of the following or equal:
   1. Verantis Environmental Solutions Group.
   2. Hartzell Fan Inc.
   3. New York Blower Co.

C. Type: fiberglass reinforced plastic backward curved centrifugal fan.

D. Operating characteristics: Non-overloading throughout entire curve at rated speed using minimum motor horsepower:

   1. Fan shall be sized by odor control system manufacturer to accommodate odor control system pressure loss and additional static pressure loss from foul air duct system.

Speed	(per manufacturer) revolutions per minute, 3000 rpm maximum
Capacity	1,200 cubic feet per minute
External Static pressure upstream of grease trap (duct system pressure drop)	2 inches water column
Total estimated fan external static pressure	5 inches water column

E. Components:
   1. Fan wheels: Solid fiberglass reinforced plastic; backwardly-inclined, non-overloading type; oven cured for maximum strength.
   2. Housing and inlet and outlet flanges: Solid fiberglass reinforced plastic.
   3. Shaft and hub: Type 316 stainless steel encapsulated in fiberglass reinforced plastic where exposed to air stream.

4. Shaft seals: Teflon™ or neoprene.
5. Bolts, nuts, and fasteners exposed to air stream: Type 316 stainless steel and encapsulated in fiberglass reinforced plastic.
6. Water trap drain: Threaded; properly sized on scroll low point.
7. Access doors: Fiberglass reinforced plastic, neoprene-gasketed, quick-opening; non-hinged.
8. Bearing life:
    a. Minimum L-10 bearing life shall be 50,000 hours in accordance with ABMA 9 or ABMA 11.
    b. Anti-friction, grease-lubricated roller or ball type.
    c. Supported on fabricated steel supports; 2 per fan.
9. Base: Heavy-gauge steel with corrosion resistant vinyl enamel coating colored to match blower; reinforces for maximum rigidity.

F. Drive and Motor:
1. Motor: Horizontal, single speed, as specified in Section 26_05_09 - Low Voltage Motors Up to 500 Horsepower with the following characteristics:

Horsepower	5 minimum, 15 maximum
Volts/phase	460/3
Frequency	60 hertz
Speed	1,800 revolutions per minute, maximum
Enclosure	TEFC
Ambient temperature	45 degrees Celsius
Temperature rise	40 degrees Celsius
Service factor	1.15
Arrangement	Arrangement Type 9 and Bottom Horizontal Discharge

2. Motor shall be furnished by fan manufacturer and shall be coordinated with the requirements of the fan.
3. V-belt drive and belt guards: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
4. Support bases: Structural steel frame; minimum 6-inch channels; coated with white corrosion-resistant vinyl enamel; mounted on vibration isolators.
5. Vibration isolators: Guided spring type with 1/4-inch neoprene isolation pad; capable of transmitting maximum 10 percent of fan and motor vibration to supporting structure.

G. Spare Parts:
1. 2 sets of belts, 1 set of bearings, and 2-year supply of grease.
2. Supply spare parts and special tools as specified in Section 01_60_00 - Product Requirements.
3. Supply 1 complete set of manufacturer's recommended spare parts.

2.09 PLANT WATER REQUIREMENTS

A. The Contractor shall provide a 2-inch NPT plant water line to the odor control vessel, as indicated on the Drawings. Plant water shall be provided at a regulated pressure up to 75 psig ± 5 psi or other as per manufacturer required water pressure. The

Contractor shall supply all utility water piping as indicated on the Drawings. All insulation and heat tracing shall be integrated and supplied by the Contractor.

2.10 INSTRUMENTATION AND CONTROLS

A. The biotrickling filter Manufacturer/supplier shall provide one PLC based master Vendor Control Panel (VCP), for the odor control system to have the logic and controls for the following components or capabilities to handle all modules. This control panel will be mounted at the odor control pad as shown on the Drawings.

B. Master VCP-44020 shall include the following items:
   1. The VCP shall be provided with a single 480 volt, 3-phase 60 hertz power supply. Distribute power to all other loads in the odor control system from the VCP.
   2. VCP shall contain all timers, circuit breakers, interlocks and input and output signals and control power to fully operate the irrigation solenoid valves and nutrient pumps, and interconnect with the utility water supply panel.
   3. VCP shall be installed with a sun shade per typical detail NM108/TYP.
   4. Components:
      a. Provide all components in accordance with Section 40_67_01 - Control Systems: Panels, Enclosures, and Panel Components.
      b. VCP shall contain a dedicated PLC.
         1) PLC hardware shall be an Allen Bradley CompactLogix 1769 series processor.
         2) Software shall be Rockwell Software RS Logix 5000 or equal.
      c. VCP shall contain a true online, double-conversion UPS Unit.
      d. VCP shall contain an internal panel light.
      e. Enclosure:
         1) NEMA 4X – rating in conformance with Sections 26_05_00 - Common Work Results for Electrical and Section 40_67_01 - Control Systems: Panels, Enclosures, and Panel Components.
         2) The control panel shall be UL approved and labeled.
      f. Main circuit breaker:
         1) As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
         2) Flange-mounted operator:
            a) Pad-lockable in the off position.
         3) Disconnects all power to the panel.
         4) Interlock with the panel door.
            a) Defeat mechanism.
      g. Motor starters and VFDs (Section 26_29_05 - Motor Starters) with motor circuit protector circuit breaker for each motor starter including but not limited to the following:
         1) Each Odor Control Fan.
         2) Each Recirculation Pump.
         3) Each Nutrient Pump.
      h. Control power transformer:
         1) Primary voltage: 460 VAC, 3-phase, 60 hertz.
         2) Secondary voltages:
            a) Additional voltages as required by the application.

3) Sized for all panel components plus 10 percent spare capacity.
4) Primary and secondary fuses.

i. Control components:
   1) Terminal strips:
      a) Provide terminal strips for landing all external wiring.
   2) Relays, timers, and other components as required providing the specified functionality and remote monitoring connections.
   3) VCP shall receive RUN/FAIL status contacts from fan FAF-44020, for the PLC programming

j. Control system programming:
   1) Programming – The vendor shall be responsible for preparing, writing, and testing all logic associated with the VCP.
   2) The vendor shall be responsible for participating in a programming conference call with the ICSC prior to beginning the program process. The purpose of the conference call will be to review the requirements for coordination between vendor and ICSC's programmer.

k. Control Devices:
   1) Master Vendor Control Panel (VCP-44020):
      a) Provide HAND-OFF-AUTO selector switch for the overall system.
      b) Provide EMERGENCY STOP mushroom head pushbutton for the entire system.
      c) Provide a shutdown RESET switch/button for operators to clear the EMERGENCY STOP activation, the smoke detector activation and/or the general failure alarm.
      d) Provide the following indicators:
         (1) Overall System Indicators:
            (a) White power on indicator.
            (b) Green system run indicator.
            (c) Amber System alarm indicator.
            (d) Amber Low Level alarm.
            (e) Red Grease Filter/Mist Eliminator high pressure drop.
         (2) Foul Air Odor Control Fan.
            (a) Green run indicator.
            (b) Red fault indicator.
            (c) Digital VFD speed indicator.
            (d) Red Low Airflow Indicator and differential pressure readout.
         (3) Nutrient Pump.
            (a) Green run indicator.
            (b) Red fault indicator.
         (4) Recirculation Pump:
            (a) Green run indicator.
            (b) Red fault indicator.
         (5) pH Monitor:
            (a) Red fault indicator when PH < 2.
         (6) Irrigation Valve.
            (a) Amber open status.
            (b) Blue closed status.

e) Provide the following push buttons:
(1) Odor Control Fan:
(a) Provide START and STOP push buttons.
(b) Provide fan VFD speed control push buttons.
(2) Nutrient Pumps (one for each):
(a) Provide START and STOP push buttons.
(3) Recirculating Pumps (one for each):
(a) Provide START and STOP push buttons.

5. Instrumentation:
a. Provide magnetic flow meters in accordance with Section 40_71_15 - Flow Measurement Magnetic Flowmeters.
6. Odor Control Operation:
a. References:
1) Section 23_09_13 - Instrumentation and Control Devices for HVAC, Section 40_61_16.10 - Specific Control Strategies.
b. Abstract:
1) The odor control fan will draw foul air from the sludge storage tanks and septic receiving station.
2) The odor control fan shall be started and stopped manually or automatically. When operating fan shall run continuously.
3) The entire odor control system shall be controlled and powered through the manufacturer provide vendor control panel, VCP-44020.
4) The biotrickling filter shall be used to remove odorous compounds from air drawn from the flow equalization basin and septic receiving station.
5) The pumps for the irrigation and nutrient feed systems shall automatically start when the odor control fan is running to maintain a healthy microbial population. Irrigation is provided by the plant PW and controlled by the water control panel. Nutrient feed is pumped during startup of the biofilter and operates for an adjustable period of time, and can be ceased once the population is established.
6) The filter unit will contain an inorganic porous substrate to support a thin film sulfur oxidizing bacteria for the removal of H_2S.
7) The VCP PLC shall be capable of sending a discrete output "General Odor Control System Failure" alarm to the plant PLC/SCADA.
c. Hardwired Control:
1) With the system HOA switch in HAND:
a) The individual equipment can be controlled by their individual control stations.
b) The fan starter is controlled by the VCP.
2) With the system HOA switch in AUTO:
a) The system is controlled by the VCP and the fan starters and VFDs are controlled by the VCP.
d. Hardwired interlocks:
1) The entire odor control system is stopped and prohibited from running if:
a) Any odor control system emergency stop pushbutton is activated. The odor control system will only restart when a manual reset is activated by the operators.

e. VCP PLC Control:
    1) With the system HOA switch in AUTO the system is controlled by the VCP PLC and the fan starters and VFDs are controlled by the VCP PLC:
        a) The starting and stopping of the system is determined by the VCP PLC.
            (1) If a FAIL status is received from the motor starter, the odor control system shall turn off.
        b) When the system is running, the VCP shall operate the overall odor control system:
            (1) The pumps for the irrigation and nutrient feed systems shall automatically start when the odor control fan is running to maintain a healthy microbial population. Irrigation is provided by the plant NPW. Nutrient feed is pumped only during startup of the biofilter and operates for an adjustable period of time and can be ceased once the population is established.
            (2) Any other necessary operation shall be controlled automatically by the VCP PLC.
f. Software Interlocks:
    1) System shall stop operating if the low level switch is activated.
    2) The irrigation and nutrient feed systems shall operate whenever the foul air fan is operating.
g. SCADA interface:
    1) Upon any type of operation alarm or failure that occurs within the odor control system, the VCP PLC shall be send a discrete "General Odor Control Failure Alarm" to the Plant PLC/SCADA.
    2) If the differential pressure indicating transmitter, PDIT, measures an increase or decrease in differential pressure across the odor control fan that deviates from +- 25 percent of the normal operation pressure. A "low airflow" alarm status shall be indicated at the VCP PLC.
    3) Provide inputs to SCADA rated 120VACVDC for the following: Running, Failed (general alarm), HOA in AUTO.
    4) Accept a hardwired 120VACVDC run command from SCADA: System start/run.
    5) Provide all other alarms via EtherNet I/P protocol connection over copper Ethernet cable.

2.11 VALVES, FITTINGS, AND CONNECTIONS

A. Material:
    1. Interior installations: Schedule 80 CPVC.
    2. Exterior installations: Schedule 80 CPVC.
    3. Type 316 stainless steel for flange bolts.

B. Valves:
    1. CPVC body diaphragm type with PTFE over EPDM diaphragms.
    2. Provide Hypalon® gaskets and O-rings; gaskets 0.125-inch thickness minimum.
    3. Flanged or true union for easy removal or replacement.

2.12 SCRUBBER RECIRCULATION PUMP

A. Rated head as required to pump liquid from the bottom sump area of a biotrickling filter to the spray nozzles at a minimum flow rate of 40 gpm or as recommended by odor control system supplier.

B. The recirculation pump motors shall be a maximum 10 Hp Premium Efficiency 460-volt, 3-phase, 60-Hz TEFC motor, having a maximum nominal speed of 1,800 RPM and a service factor of 1.15, in accordance with specification Section 26_05_09 - Low Voltage Motors up to 500 Horsepower. The drive unit shall be approved for use in a Class I, Division 2, Group D environment. Provide an IEEE 841 compliant motor.

2.13 NUTRIENT PUMP

A. Maximum pressure must not exceed 100 psi.

B. The nutrient pump shall be 115V, 6-Hz, with a maximum output capacity of 1.0 gph or as recommended by odor control system supplier.

2.14 ACCESSORIES

A. Lifting Lugs: Equipment weighing over 70 pounds.
   1. Provide a minimum of 4 lifting lugs for biotrickling filter vessel for use in transporting and placing the vessel.

B. Anchor bolts shall be provided by the Contractor in accordance with Section 46_05_10 - Common Work Results for Mechanical Equipment.

C. Biotrickling Filter Level Switches.

2.15 FINISHES

A. Gel-coat the odor control scrubber system piping and equipment. Plastic or fiber reinforced thermoset plastic resin vessels, tanks and equipment shall be pigmented in a color selected by the Engineer and contain ultraviolet light inhibitors.

2.16 SOURCE QUALITY CONTROL

A. Factory Test: Perform Manufacturer's standard test on equipment. Provide an independent FRP Quality Assurance Inspection report as follows:
   1. Visual inspection to the requirements of ASTM D2563.
   2. Barcol Hardness measurements in accordance with ASTM D2583.
   3. Acetone sensitivity test for all internal secondary bonds.
   4. Glass content by ignition loss on 3 cutouts in accordance with ASTM D2584.

B. Factory Test: Provide certified test reports for the noise level of the fans in conformance with AMCA 300 and ANSI S1.6.

C. Factory Test: All water panel piping and/or other pre-installed piping shall be tested prior to shipping for conformance to the following:
   1. System shall have no leaks when subjected to a pressure test at 80 psi for a minimum of 1 hour.
   2. All installed instruments, sensors, pumps, actuated valves, and other electrical components shall be tested for proper operation.
   3. All wiring from terminal strips to all electrical components shall be tested to ensure proper wiring.
   4. Spray nozzle shall be factory tested to ensure compliance with Manufacturer standards for uniform distribution.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Provide the following:
      a. Inspect equipment upon delivery to job site.
      b. Perform installation of biotrickling filter system equipment including any adjustments, and installation checks for equipment and controls.
      c. Certify alignment and proper control functioning prior to operations.
      d. Conduct start-up of all equipment and perform all required tests including instrument calibration and loop checking and performance testing of components that function as part of the odor control system.
      e. Provide written statement that equipment has been installed properly and is ready for operation by Owner.

3.03 SYSTEM BALANCING AND CHECKING

A. After the odor control system has been installed, checked-out, controls tested, and is ready for operation, test and balance the entire foul air system as specified for air systems in Section 23_05_93 - Testing, Adjusting, and Balancing for HVAC.
   1. Calibrate and adjust all instruments necessary for biotrickling filter system operation.
      a. Adjust controls to achieve the required performance at the rated design condition.
      b. The odor control system supplier shall inspect ductwork, dampers, and expansion joint installation.

3.04 FIELD FINISHING (AND/OR CORROSION PROTECTION)

A. Field touch up in accordance with Section 09_96_01 - High-Performance Coatings.

B. Damage to pigmented gel coat and/or exterior laminate on any FRP component shall be repaired in accordance with equipment fabricator's recommendations. Exposed surfaces will be restored to a uniform texture and color-matched appearance. Color shall be as selected by the Owner.

3.05 FIELD QUALITY CONTROL

A. The Contractor shall provide Field Quality Control Tests in Accordance with Section 01_75_17 - Commissioning, and as follows:
   1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
   2. Provide Field Quality Control Tests in accordance with Section 01_75_17 - Commissioning, and as follows:
      a. Conduct airflow test for the biotrickling filter. Flow test equipment shall be certified to provide accuracy to within plus or minus 5 percent of design flow.
      b. Provide pressure differential reading across the vessel. Provide equipment and ports as required for Owner to do monthly operational testing on these locations. Provide a 3/4-inch PVC pipe that extends from the exhaust stack to 4 ft from the base, with standoffs along the side of the vessel. A valve will be included to close of the lower end of the tubing. A 3/4-inch PVC inlet sample port with ball valve shall be provided at the vessel inlet.
      c. Performance Tests: Coordinate tests with associated instrumentation and control system. Conduct performance test on biotrickling filter system under actual operating conditions of the site as follows:
         1) Test only after supplier approved acclimation period for biotrickling filter. Acclimation is not to exceed 6 weeks. The acclimation of the biotrickling filter media shall be the responsibility of the supplier.
         2) Use portable hydrogen sulfide analyzers to record inlet and outlet concentrations at least 10-minute intervals, or less (more often). Analyzers shall be Acrulog PPM/PPB or equal units for continuous monitoring. Single point sampling may be performed by Draeger tube or Jerome meter.
         3) Test the biotrickling filter under actual normal operating conditions for 7 continuous days using continuous sampling devices that measure inlet and outlet H2S levels at no greater than 10-minute intervals. Use ranges 0-1000 ppm for inlet and 0-2000 ppb for outlet.
            a) Verify the required reduction of H2S as specified in the performance table herein.
         4) Provide anemometer or pitot tube instrument on the unit discharge for verification of airflow requirements.
         5) A report of the performance test results shall be provided.

3.06 SYSTEM SUPPLIER SERVICES

A. Provide Manufacturer's services at the jobsite for the following time period as follows:
   1. Manufacturer's assistance to the Contractor to include requirements per subsection 3.03.A.1: 2 days and 1 trip.
   2. Manufacturer's Certificate of Proper Installation.
   3. Manufacturer's Training Program: 2 days and 1 trip.
   4. Field Testing: 7 days and 1 trip.

B. Other Services:
   1. Certify alignment and proper functioning prior to operations.
   2. Provided written statement that equipment has been installed properly and is ready for operation by Owner.

3.07 SYSTEM SUPPLIER SEMIANNUAL SERVICE

A. The equipment Manufacturer shall perform semiannual services at the job site during the first two years (2 visits per year). The services shall include a site visit every 6 months by a factory technician for equipment inspection, performance testing, checkout, and adjustment.

B. In addition to the semi-annual services, the following services shall be conducted periodically:
   1. Measure airflow rate of the biotrickling filter system each 6 months.
   2. Re-gasket as necessary.
   3. Repair or replace malfunctioning equipment.

C. The equipment Manufacturer shall submit a written report following each visit for the semiannual services and an annual report.

D. Only services conducted by a factory technician are acceptable. Services conducted by a Manufacturer's representative or agent, are not acceptable.

E. Cost of the service visits shall be included in the bid amount for the odor control system but shall be invoiced directly by the system supplier to the Owner after each visit. Payment will be made directly to the system supplier.

END OF SECTION

APPENDIX A:
STATE WAGE RATES
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

This project is a public work subject to State of Washington prevailing wage law, Chapter 39.12 RCW. Prevailing wage rates applicable to this project, which is located in Whatcom County, Washington, are available on the Washington State Department of Labor & Industries' website at: https://secure.Lni.wa.gov/wagelookup . The applicable effective date for prevailing wages is the bid submittal deadline. A hard copy of applicable prevailing wage rates is available for viewing at the City's Purchasing Office and will be mailed upon request.

State of Washington
Department of Labor & Industries
Prevailing Wage Section - Telephone 360-902-5335
PO Box 44540, Olympia, WA 98504-4540

Washington State Prevailing Wage
The PREVAILING WAGES listed here include both the hourly wage rate and the hourly rate of fringe benefits. On public works projects, worker's wage and benefit rates must add to not less than this total. A brief description of overtime calculation requirements are provided on the Benefit Code Key.

Journey Level Prevailing Wage Rates for the Effective Date: 10/15/2026

Whatcom County

Trade	Job Classification	Wage	Holiday	Overtime	Note
Asbestos Abatement Workers	Journey Level	$71.10	**5D**	**1H**	
Boilermakers	Journey Level	$83.89	**5N**	**1C**	
Brick Mason	Journey Level	$82.00	**7E**	**1N**	
Brick Mason	Pointer-Caulker-Cleaner	$82.00	**7E**	**1N**	
Building Service Employees	Janitor	$17.13		**1**	
Building Service Employees	Shampooer	$17.13		**1**	
Building Service Employees	Waxer	$17.13		**1**	

Building Service Employees	Window Cleaner	$17.13		**1**	
Cabinet Makers (In Shop)	Journey Level	$24.89		**1**	
Carpenters	Acoustical Worker	$87.71	**15J**	**11U**	
Carpenters	Bridge Dock and Wharf Carpenter	$89.38	**15J**	**11U**	**9L**
Carpenters	Floor Layer & Floor Finisher	$87.71	**15J**	**11U**	
Carpenters	General Carpenter	$87.71	**15J**	**11U**	
Carpenters	Scaffold Erector	$87.71	**15J**	**11U**	
Cement Masons	Application of all Composition Mastic	$86.70	**15J**	**4U**	
Cement Masons	Application of all Epoxy Material	$86.18	**15J**	**4U**	
Cement Masons	Application of all Plastic Material	$86.70	**15J**	**4U**	
Cement Masons	Application of Sealing Compound	$86.18	**15J**	**4U**	
Cement Masons	Application of Underlayment	$86.70	**15J**	**4U**	
Cement Masons	Building General	$86.18	**15J**	**4U**	
Cement Masons	Composition or Kalman Floors	$86.70	**15J**	**4U**	

Cement Masons	Concrete Paving	$86.18	**15J**	**4U**
Cement Masons	Curb & Gutter Machine	$86.70	**15J**	**4U**
Cement Masons	Curb & Gutter, Sidewalks	$86.18	**15J**	**4U**
Cement Masons	Curing Concrete	$86.18	**15J**	**4U**
Cement Masons	Finish Colored Concrete	$86.70	**15J**	**4U**
Cement Masons	Floor Grinding	$86.70	**15J**	**4U**
Cement Masons	Floor Grinding/Polisher	$86.18	**15J**	**4U**
Cement Masons	Green Concrete Saw, self-powered	$86.70	**15J**	**4U**
Cement Masons	Grouting of all Plates	$86.18	**15J**	**4U**
Cement Masons	Grouting of all Tilt-up Panels	$86.18	**15J**	**4U**
Cement Masons	Gunite Nozzleman	$86.70	**15J**	**4U**
Cement Masons	Hand Powered Grinder	$86.70	**15J**	**4U**
Cement Masons	Journey Level	$86.18	**15J**	**4U**
Cement Masons	Patching Concrete	$86.18	**15J**	**4U**
Cement Masons	Pneumatic Power Tools	$86.70	**15J**	**4U**
Cement Masons	Power Chipping & Brushing	$86.70	**15J**	**4U**

Cement Masons	Sand Blasting Architectural Finish	$86.70	**15J**	**4U**	
Cement Masons	Screed & Rodding Machine	$86.70	**15J**	**4U**	
Cement Masons	Spackling or Skim Coat Concrete	$86.18	**15J**	**4U**	
Cement Masons	Troweling Machine Operator	$86.70	**15J**	**4U**	
Cement Masons	Troweling Machine Operator on Colored Slabs	$86.70	**15J**	**4U**	
Cement Masons	Tunnel Workers	$86.70	**15J**	**4U**	
Divers & Tenders	Bell/Vehicle/Submersible Operator (not under pressure)	$149.22	**15J**	**11T**	**9I**
Divers & Tenders	Dive Supervisor	$150.72	**15J**	**11T**	**9I**
Divers & Tenders	Diver	$149.22	**15J**	**11T**	**9I**
Divers & Tenders	Diver Tender	$95.55	**15J**	**11T**	**9I**
Divers & Tenders	Hyperbaric Worker - Compressed Air Worker 0-30.00 PSI	$120.22	**15J**	**11U**	
Divers & Tenders	Hyperbaric Worker - Compressed Air Worker 30.01-44.00 PSI	$130.16	**15J**	**11U**	

Divers & Tenders	Hyperbaric Worker - Compressed Air Worker 44.01 - 54.00 PSI	$140.11	**15J**	**11U**	
Divers & Tenders	Hyperbaric Worker - Compressed Air Worker 54.01 - 60.00 PSI	$150.05	**15J**	**11U**	
Divers & Tenders	Hyperbaric Worker - Compressed Air Worker 60.01 - 64.00 PSI	$160.00	**15J**	**11U**	
Divers & Tenders	Hyperbaric Worker - Compressed Air Worker 64.01 - 68.00 PSI	$169.94	**15J**	**11U**	
Divers & Tenders	Hyperbaric Worker - Compressed Air Worker 68.01 - 70.00 PSI	$179.88	**15J**	**11U**	
Divers & Tenders	Hyperbaric Worker - Compressed Air Worker 70.01 - 72.00 PSI	$189.83	**15J**	**11U**	
Divers & Tenders	Hyperbaric Worker - Compressed Air Worker 72.01 - 74.00 PSI	$199.77	**15J**	**11U**	
Divers & Tenders	Lead Diver (Dive Master)	$110.01	**15J**	**11T**	**9I**
Divers & Tenders	Manifold Operator (Life Support Technician)	$100.55	**15J**	**11U**	**9I**
Divers & Tenders	Remote Operated Vehicle Operator/Technician	$95.55	**15J**	**11U**	**9I**

Divers & Tenders	Remote Operated Vehicle Operator/Technician	$95.55	**15J**	**11T**	**9I**
Divers & Tenders	Remote Operated Vehicle Tender	$89.25	**15J**	**11T**	**9I**
Divers & Tenders	Stand-by Diver	$105.01	**15J**	**11T**	**9I**
Drywall Applicator	Journey Level	$84.77	**15O**	**11S**	
Drywall Tapers	Journey Level	$84.77	**15O**	**11S**	
Electrical Fixture Maintenance Workers	Journey Level	$17.13		**1**	
Electricians - Inside	Cable Splicer	$105.08	**7H**	**1E**	
Electricians - Inside	Construction Stock Person	$50.14	**7H**	**1D**	
Electricians - Inside	Journey Level	$98.34	**7H**	**1E**	
Electricians - Motor Shop	Craftsman	$17.13		**1**	
Electricians - Motor Shop	Journey Level	$17.13		**1**	
Electricians - Powerline Construction	Cable Splicer	$107.31	**5A**	**4D**	
Electricians - Powerline Construction	Certified Line Welder	$98.45	**5A**	**4D**	
Electricians - Powerline Construction	Groundperson	$61.75	**5A**	**4D**	

Electricians - Powerline Construction	Heavy Line Equipment Operator	$98.45	**5A**	**4D**	
Electricians - Powerline Construction	Journey Level Lineperson	$98.45	**5A**	**4D**	
Electricians - Powerline Construction	Line Equipment Operator	$84.94	**5A**	**4D**	
Electricians - Powerline Construction	Meter Installer	$61.75	**5A**	**4D**	**8W**
Electricians - Powerline Construction	Pole Sprayer	$98.45	**5A**	**4D**	
Electricians - Powerline Construction	Powderperson	$72.81	**5A**	**4D**	
Electronic Technicians	Electronic Technicians Journey Level	$65.58	**5B**	**1B**	
Elevator Constructors	Mechanic	$119.17	**7D**	**4A**	
Elevator Constructors	Mechanic In Charge	$128.95	**7D**	**4A**	
Fabricated Precast Concrete Products	Journey Level	$17.13		**1**	
Fabricated Precast Concrete Products	Journey Level - In-Factory Work Only	$17.13		**1**	
Fence Erectors	Fence Erector	$60.82	**15J**	**11X**	**9N**
Fence Erectors	Fence Laborer	$60.82	**15J**	**11X**	**9N**
Flaggers	Journey Level	$60.82	**15J**	**11X**	**9N**

Glaziers	Journey Level	$88.41	**7L**	**1Y**	
Heat & Frost Insulators And Asbestos Workers	Journey Level	$100.83	**15H**	**11C**	
Heating Equipment Mechanics	Mechanic	$103.56	**7F**	**1E**	
Hod Carriers & Mason Tenders	Journey Level	$75.00	**15J**	**11X**	**9N**
Industrial Power Vacuum Cleaner	Journey Level	$17.13		**1**	
Inland Boatmen	Boat Operator	$71.28	**5B**	**1K**	
Inland Boatmen	Cook	$69.70	**5B**	**1K**	
Inland Boatmen	Deckhand	$70.00	**5B**	**1K**	
Inland Boatmen	Deckhand Engineer	$69.55	**5B**	**1K**	
Inland Boatmen	Launch Operator	$71.23	**5B**	**1K**	
Inland Boatmen	Mate	$89.12	**5B**	**1K**	
Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	Cleaner Operator	$58.17	**15M**	**11O**	
Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	Foamer Operator	$58.17	**15M**	**11O**	
Inspection/Cleaning/Sealing Of Sewer & Water Systems	Grout Truck Operator	$58.17	**15M**	**11O**	

By Remote Control					
Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	Head Operator	$56.10	**15M**	**11O**	
Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	Technician	$49.90	**15M**	**11O**	
Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	TV Truck Operator	$53.00	**15M**	**11O**	
Insulation Applicators	Journey Level	$87.71	**15J**	**11U**	
Ironworkers	Journeyman	$94.82	**15K**	**11N**	
Laborers	Air, Gas Or Electric Vibrating Screed	$71.10	**15J**	**11X**	**9N**
Laborers	Airtrac Drill Operator	$73.18	**15J**	**11X**	**9N**
Laborers	Ballast Regular Machine	$71.10	**15J**	**11X**	**9N**
Laborers	Batch Weighman	$60.82	**15J**	**11X**	**9N**
Laborers	Brick Pavers	$71.10	**15J**	**11X**	**9N**
Laborers	Brush Cutter	$71.10	**15J**	**11X**	**9N**
Laborers	Brush Hog Feeder	$71.10	**15J**	**11X**	**9N**
Laborers	Burner	$71.10	**15J**	**11X**	**9N**

Laborers	Caisson Worker	$73.18	**15J**	**11X**	**9N**
Laborers	Carpenter Tender	$71.10	**15J**	**11X**	**9N**
Laborers	Cement Dumper-paving	$73.18	**15J**	**11X**	**9N**
Laborers	Cement Finisher Tender	$71.10	**15J**	**11X**	**9N**
Laborers	Change House Or Dry Shack	$71.10	**15J**	**11X**	**9N**
Laborers	Chipping Gun (30 Lbs. And Over)	$72.33	**15J**	**11X**	**9N**
Laborers	Chipping Gun (Under 30 Lbs.)	$71.10	**15J**	**11X**	**9N**
Laborers	Choker Setter	$71.10	**15J**	**11X**	**9N**
Laborers	Chuck Tender	$71.10	**15J**	**11X**	**9N**
Laborers	Clary Power Spreader	$72.33	**15J**	**11X**	**9N**
Laborers	Clean-up Laborer	$71.10	**15J**	**11X**	**9N**
Laborers	Concrete Dumper/Chute Operator	$73.18	**15J**	**11X**	**9N**
Laborers	Concrete Form Stripper	$71.10	**15J**	**11X**	**9N**
Laborers	Concrete Placement Crew	$73.18	**15J**	**11X**	**9N**
Laborers	Concrete Saw Operator/Core Driller	$72.33	**15J**	**11X**	**9N**

Laborers	Crusher Feeder	$60.82	**15J**	**11X**	**9N**
Laborers	Curing Laborer	$71.10	**15J**	**11X**	**9N**
Laborers	Demolition: Wrecking & Moving (Incl. Charred Material)	$71.10	**15J**	**11X**	**9N**
Laborers	Ditch Digger	$71.10	**15J**	**11X**	**9N**
Laborers	Diver	$73.18	**15J**	**11X**	**9N**
Laborers	Drill Operator (Hydraulic, Diamond)	$72.33	**15J**	**11X**	**9N**
Laborers	Dry Stack Walls	$71.10	**15J**	**11X**	**9N**
Laborers	Dump Person	$71.10	**15J**	**11X**	**9N**
Laborers	Epoxy Technician	$71.10	**15J**	**11X**	**9N**
Laborers	Erosion Control Worker	$71.10	**15J**	**11X**	**9N**
Laborers	Faller & Bucker Chain Saw	$72.33	**15J**	**11X**	**9N**
Laborers	Fine Graders	$71.10	**15J**	**11X**	**9N**
Laborers	Firewatch	$60.82	**15J**	**11X**	**9N**
Laborers	Form Setter	$73.18	**15J**	**11X**	**9N**
Laborers	Gabian Basket Builders	$71.10	**15J**	**11X**	**9N**
Laborers	General Laborer	$71.10	**15J**	**11X**	**9N**

Laborers	Grade Checker & Transit Person	$75.00	**15J**	**11X**	**9N**
Laborers	Grinders	$71.10	**15J**	**11X**	**9N**
Laborers	Grout Machine Tender	$71.10	**15J**	**11X**	**9N**
Laborers	Groutmen (Pressure) Including Post Tension Beams	$72.33	**15J**	**11X**	**9N**
Laborers	Guardrail Erector	$71.10	**15J**	**11X**	**9N**
Laborers	Hazardous Waste Worker (Level A)	$73.18	**15J**	**11X**	**9N**
Laborers	Hazardous Waste Worker (Level B)	$72.33	**15J**	**11X**	**9N**
Laborers	Hazardous Waste Worker (Level C)	$71.10	**15J**	**11X**	**9N**
Laborers	High Scaler	$73.18	**15J**	**11X**	**9N**
Laborers	Jackhammer	$72.33	**15J**	**11X**	**9N**
Laborers	Laserbeam Operator	$72.33	**15J**	**11X**	**9N**
Laborers	Maintenance Person	$71.10	**15J**	**11X**	**9N**
Laborers	Manhole Builder-Mudman	$72.33	**15J**	**11X**	**9N**
Laborers	Material Yard Person	$71.10	**15J**	**11X**	**9N**
Laborers	Mold Abatement Worker	$71.10	**15J**	**11X**	**9N**

Laborers	Motorman-Dinky Locomotive	$75.05	**15J**	**11X**	**9N**
Laborers	nozzleman (concrete pump, green cutter when using combination of high pressure air & water on concrete & rock, sandblast, gunite, shotcrete, water blaster, vacuum blaster)	$75.00	**15J**	**11X**	**9N**
Laborers	Pavement Breaker	$72.33	**15J**	**11X**	**9N**
Laborers	Pilot Car	$60.82	**15J**	**11X**	**9N**
Laborers	Pipe Layer (Lead)	$75.00	**15J**	**11X**	**9N**
Laborers	Pipe Layer/Tailor	$72.33	**15J**	**11X**	**9N**
Laborers	Pipe Pot Tender	$72.33	**15J**	**11X**	**9N**
Laborers	Pipe Reliner	$72.33	**15J**	**11X**	**9N**
Laborers	Pipe Wrapper	$72.33	**15J**	**11X**	**9N**
Laborers	Pot Tender	$71.10	**15J**	**11X**	**9N**
Laborers	Powderman	$73.18	**15J**	**11X**	**9N**
Laborers	Powderman's Helper	$71.10	**15J**	**11X**	**9N**
Laborers	Power Jacks	$72.33	**15J**	**11X**	**9N**

Laborers	Power Washer	$71.10	**15J**	**11X**	**9N**
Laborers	Railroad Spike Puller - Power	$72.33	**15J**	**11X**	**9N**
Laborers	Raker - Asphalt	$75.00	**15J**	**11X**	**9N**
Laborers	Re-timberman	$73.18	**15J**	**11X**	**9N**
Laborers	Remote Equipment Operator	$72.33	**15J**	**11X**	**9N**
Laborers	Rigger/Signal Person	$72.33	**15J**	**11X**	**9N**
Laborers	Rip Rap Person	$71.10	**15J**	**11X**	**9N**
Laborers	Rivet Buster	$72.33	**15J**	**11X**	**9N**
Laborers	Rodder	$73.18	**15J**	**11X**	**9N**
Laborers	Scaffold Erector	$71.10	**15J**	**11X**	**9N**
Laborers	Scale Person	$71.10	**15J**	**11X**	**9N**
Laborers	Sloper (Over 20")	$72.33	**15J**	**11X**	**9N**
Laborers	Sloper Sprayer	$71.10	**15J**	**11X**	**9N**
Laborers	Spreader (Concrete)	$73.18	**15J**	**11X**	**9N**
Laborers	Stake Hopper	$71.10	**15J**	**11X**	**9N**
Laborers	Stock Piler	$71.10	**15J**	**11X**	**9N**

Laborers	Swinging Stage/Boatswain Chair	$60.82	**15J**	**11X**	**9N**
Laborers	Tamper & Similar Electric, Air & Gas Operated Tools	$72.33	**15J**	**11X**	**9N**
Laborers	Tamper (Multiple & Self-propelled)	$72.33	**15J**	**11X**	**9N**
Laborers	Timber Person - Sewer (Lagger, Shorer & Cribber)	$72.33	**15J**	**11X**	**9N**
Laborers	Toolroom Person (at Jobsite)	$71.10	**15J**	**11X**	**9N**
Laborers	Topper	$71.10	**15J**	**11X**	**9N**
Laborers	Track Laborer	$71.10	**15J**	**11X**	**9N**
Laborers	Track Liner (Power)	$72.33	**15J**	**11X**	**9N**
Laborers	Traffic Control Laborer	$64.78	**15J**	**11X**	**9P**
Laborers	Traffic Control Supervisor	$68.42	**15J**	**11P**	**9C**
Laborers	Traffic Control Supervisor	$68.42	**15J**	**11X**	**9P**
Laborers	Truck Mounted Attenuator	$64.78	**15J**	**11X**	**9P**
Laborers	Truck Spotter	$71.10	**15J**	**11X**	**9N**
Laborers	Tugger Operator	$72.33	**15J**	**11X**	**9N**
Laborers	Tunnel Work-Compressed Air Worker 0-30 psi	$254.08	**15J**	**11X**	**9Q**

Laborers	Tunnel Work-Compressed Air Worker 30.01-44.00 psi	$259.24	**15J**	**11X**	**9Q**
Laborers	Tunnel Work-Compressed Air Worker 44.01-54.00 psi	$263.01	**15J**	**11X**	**9Q**
Laborers	Tunnel Work-Compressed Air Worker 54.01-60.00 psi	$268.85	**15J**	**11X**	**9Q**
Laborers	Tunnel Work-Compressed Air Worker 60.01-64.00 psi	$271.02	**15J**	**11X**	**9Q**
Laborers	Tunnel Work-Compressed Air Worker 64.01-68.00 psi	$276.25	**15J**	**11X**	**9Q**
Laborers	Tunnel Work-Compressed Air Worker 68.01-70.00 psi	$278.20	**15J**	**11X**	**9Q**
Laborers	Tunnel Work-Compressed Air Worker 70.01-72.00 psi	$280.25	**15J**	**11X**	**9Q**
Laborers	Tunnel Work-Compressed Air Worker 72.01-74.00 psi	$282.30	**15J**	**11X**	**9Q**
Laborers	Tunnel Work-Guage and Lock Tender	$75.05	**15J**	**11X**	**9N**
Laborers	Tunnel Work-Miner	$75.05	**15J**	**11X**	**9N**

Laborers	Vibrator	$73.18	**15J**	**11X**	**9N**
Laborers	Vinyl Seamer	$71.10	**15J**	**11X**	**9N**
Laborers	Watchman	$55.62	**15J**	**11X**	**9N**
Laborers	Welder	$72.33	**15J**	**11X**	**9N**
Laborers	Well Point Laborer	$72.33	**15J**	**11X**	**9N**
Laborers	Window Washer/Cleaner	$55.62	**15J**	**11X**	**9N**
Laborers - Underground Sewer & Water	General Laborer & Topman	$71.10	**15J**	**11X**	**9N**
Laborers - Underground Sewer & Water	Pipe Layer	$72.33	**15J**	**11X**	**9N**
Landscape Construction	Landscape Construction/Landscaping Or Planting Laborers	$55.62	**15J**	**11X**	**9N**
Landscape Construction	Landscape Operator	$93.00	**15J**	**11G**	**8X**
Landscape Maintenance	Groundskeeper	$17.13		**1**	
Lathers	Journey Level	$84.77	**15O**	**11S**	
Marble Setters	Journey Level	$82.00	**7E**	**1N**	
Metal Fabrication (In Shop)	Journey Level	$33.09	**15G**	**11B**	
Millwright	Journey Level	$80.28	**15J**	**4C**	

Modular Buildings	Journey Level	$17.13		1	
Painters	Journey Level	$58.84	6Z	11J	
Pile Driver	Crew Tender	$80.50	15J	11U	9L
Pile Driver	Journey Level	$89.43	15J	11U	
Plasterers	Journey Level	$81.34	7Q	1R	
Plasterers	Nozzleman	$85.44	7Q	1R	
Playground & Park Equipment Installers	Journey Level	$17.13		1	
Plumbers & Pipefitters	Journey Level	$99.87	5A	1G	
Power Equipment Operators	Asphalt Plant Operators	$94.54	15J	11G	8X
Power Equipment Operators	Assistant Engineer	$88.90	15J	11G	8X
Power Equipment Operators	Barrier Machine (zipper)	$93.71	15J	11G	8X
Power Equipment Operators	Batch Plant Operator: concrete	$93.71	15J	11G	8X
Power Equipment Operators	Boat Operator	$96.51	7A	11H	8X
Power Equipment Operators	Bobcat	$88.90	15J	11G	8X

Power Equipment Operators	Brokk - Remote Demolition Equipment	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Brooms	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Bump Cutter	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Cableways	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Chipper	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Compressor	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Concrete Finish Machine - Laser Screed	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Concrete Pump - Mounted Or Trailer High Pressure Line Pump, Pump High Pressure	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Concrete Pump: Truck Mount With Boom Attachment Over 42 M	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Concrete Pump: Truck Mount With Boom Attachment Up To 42m	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Conveyors	$93.00	**15J**	**11G**	**8X**

Power Equipment Operators	Cranes Friction: 200 tons and over	$99.42	**7A**	**11H**	**8X**
Power Equipment Operators	Cranes, A-frame: 10 tons and under	$90.77	**7A**	**11H**	**8X**
Power Equipment Operators	Cranes: 100 tons through 199 tons, or 150' of boom (including jib with attachments)	$97.46	**7A**	**11H**	**8X**
Power Equipment Operators	Cranes: 20 tons through 44 tons with attachments	$95.64	**7A**	**11H**	**8X**
Power Equipment Operators	Cranes: 200 tons- 299 tons, or 250' of boom including jib with attachments	$98.47	**7A**	**11H**	**8X**
Power Equipment Operators	Cranes: 300 tons and over or 300' of boom including jib with attachments	$99.42	**7A**	**11H**	**8X**
Power Equipment Operators	Cranes: 45 tons through 99 tons, under 150' of boom(including jib with attachments)	$96.51	**7A**	**11H**	**8X**
Power Equipment Operators	Cranes: Friction cranes through 199 tons	$98.47	**7A**	**11H**	**8X**
Power Equipment Operators	Cranes: through 19 tons with attachments, a-frame over 10 tons	$94.93	**7A**	**11H**	**8X**

Power Equipment Operators	Crusher	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Deck Engineer/Deck Winches (power)	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Derricks, On Building Work	$96.51	**7A**	**11H**	**8X**
Power Equipment Operators	Dozers D-9 & Under	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Drill Oilers: Auger Type, Truck Or Crane Mount	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Drilling Machine	$95.53	**15J**	**11G**	**8X**
Power Equipment Operators	Elevator and man-lift: permanent and shaft type	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Finishing Machine, Bidwell And Gamaco & Similar Equipment	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Forklift: 3000 lbs and over with attachments	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Forklifts: under 3000 lbs. with attachments	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Grade Engineer: Using Blue Prints, Cut Sheets, Etc	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Gradechecker/Stakeman	$88.90	**15J**	**11G**	**8X**

Power Equipment Operators	Guardrail Punch	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Hard Tail End Dump Articulating Off- Road Equipment 45 Yards. & Over	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Hard Tail End Dump Articulating Off-road Equipment Under 45 Yards	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Horizontal/Directional Drill Locator	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Horizontal/Directional Drill Operator	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Hydralifts/Boom Trucks Over 10 Tons	$94.93	**7A**	**11H**	**8X**
Power Equipment Operators	Hydralifts/boom trucks: 10 tons and under	$90.77	**7A**	**11H**	**8X**
Power Equipment Operators	Leverman	$96.49	**15J**	**11G**	**8X**
Power Equipment Operators	Loader, Overhead, 6 Yards. But Not Including 8 Yards	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Loaders, Overhead Under 6 Yards	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Loaders, Plant Feed	$93.71	**15J**	**11G**	**8X**

Power Equipment Operators	Loaders: Elevating Type Belt	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Locomotives, All	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Material Transfer Device	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Mechanics: All (Leadmen - $0.50 per hour over mechanic)	$95.53	**15J**	**11G**	**8X**
Power Equipment Operators	Motor Patrol Graders	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Mucking Machine, Mole, Tunnel Drill, Boring, Road Header And/or Shield	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Oil Distributors, Blower Distribution & Mulch Seeding Operator	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Outside Hoists (Elevators and Manlifts), Air Tuggers, Strato	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Overhead, bridge type Crane: 20 tons through 44 tons	$95.64	**7A**	**11H**	**8X**
Power Equipment Operators	Overhead, bridge type: 100 tons and over	$97.46	**7A**	**11H**	**8X**

Power Equipment Operators	Overhead, bridge type: 45 tons through 99 tons	$96.51	**7A**	**11H**	**8X**
Power Equipment Operators	Pavement Breaker	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Pile Driver (other Than Crane Mount)	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Plant Oiler - Asphalt, Crusher	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Posthole Digger, Mechanical	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Power Plant	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Pumps - Water	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Quad 9, Hd 41, D10 And Over	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Quick tower: no cab, under 100 feet in height base to boom	$94.93	**7A**	**11H**	**8X**
Power Equipment Operators	Remote Control Operator On Rubber Tired Earth Moving Equipment	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Rigger and Bellman	$90.77	**7A**	**11H**	**8X**
Power Equipment Operators	Rigger/Signal Person, Bellman(Certified)	$94.93	**7A**	**11H**	**8X**

Power Equipment Operators	Rollagon	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Roller, Other Than Plant Mix	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Roller, Plant Mix Or Multi-lift Materials	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Roto-mill, Roto-grinder	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Saws - Concrete	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Scraper, Self Propelled Under 45 Yards	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Scrapers - Concrete & Carry All	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Scrapers, Self-propelled: 45 Yards And Over	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Service Engineers: Equipment	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Shotcrete/Gunite Equipment	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Shovel, Excavator, Backhoe, Tractors Under 15 Metric Tons	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Shovel, Excavator, Backhoe: Over 30 Metric Tons To 50 Metric Tons	$94.54	**15J**	**11G**	**8X**

Power Equipment Operators	Shovel, Excavator, Backhoes, Tractors: 15 To 30 Metric Tons	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Shovel, Excavator, Backhoes: Over 50 Metric Tons To 90 Metric Tons	$95.53	**15J**	**11G**	**8X**
Power Equipment Operators	Shovel, Excavator, Backhoes: Over 90 Metric Tons	$96.49	**15J**	**11G**	**8X**
Power Equipment Operators	Slipform Pavers	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Spreader, Topsider & Screedman	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Subgrader Trimmer	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Tower Bucket Elevators	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Tower Crane: over 175' through 250' in height, base to boom	$98.47	**7A**	**11H**	**8X**
Power Equipment Operators	Tower crane: up to 175' in height base to boom	$97.46	**7A**	**11H**	**8X**
Power Equipment Operators	Tower Cranes: over 250' in height from base to boom	$99.42	**7A**	**11H**	**8X**
Power Equipment Operators	Transporters, All Track Or Truck Type	$94.54	**15J**	**11G**	**8X**

Power Equipment Operators	Trenching Machines	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators	Truck Crane Oiler/Driver: 100 tons and over	$95.64	**7A**	**11H**	**8X**
Power Equipment Operators	Truck crane oiler/driver: under 100 tons	$94.93	**7A**	**11H**	**8X**
Power Equipment Operators	Truck Mount Portable Conveyor	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Vac Truck (Vactor Guzzler, Hydro Excavator)	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators	Welder	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators	Wheel Tractors, Farmall Type	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators	Yo Yo Pay Dozer	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Asphalt Plant Operators	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Assistant Engineer	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Barrier Machine (zipper)	$93.71	**15J**	**11G**	**8X**

Power Equipment Operators- Underground Sewer & Water	Batch Plant Operator, Concrete	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Boat Operator	$96.51	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Bobcat	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Brokk - Remote Demolition Equipment	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Brooms	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Bump Cutter	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Cableways	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Chipper	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Compressor	$88.90	**15J**	**11G**	**8X**

Power Equipment Operators- Underground Sewer & Water	Concrete Finish Machine - Laser Screed	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Concrete Pump - Mounted Or Trailer High Pressure Line Pump, Pump High Pressure	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Concrete Pump: Truck Mount With Boom Attachment Over 42 M	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Concrete Pump: Truck Mount With Boom Attachment Up To 42m	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Conveyors	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Cranes Friction: 200 tons and over	$99.42	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Cranes, A-frame: 10 tons and under	$90.77	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Cranes: 100 tons through 199 tons, or 150' of boom (including jib with attachments)	$97.46	**7A**	**11H**	**8X**

Power Equipment Operators- Underground Sewer & Water	Cranes: 20 tons through 44 tons with attachments	$95.64	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Cranes: 200 tons- 299 tons, or 250' of boom including jib with attachments	$98.47	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Cranes: 300 tons and over or 300' of boom including jib with attachments	$99.42	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Cranes: 45 tons through 99 tons, under 150' of boom(including jib with attachments)	$96.51	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Cranes: Friction cranes through 199 tons	$98.47	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Cranes: through 19 tons with attachments, a-frame over 10 tons	$94.93	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Crusher	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Deck Engineer/Deck Winches (power)	$93.71	**15J**	**11G**	**8X**

Power Equipment Operators- Underground Sewer & Water	Derricks, On Building Work	$96.51	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Dozers D-9 & Under	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Drill Oilers: Auger Type, Truck Or Crane Mount	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Drilling Machine	$95.53	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Elevator and man-lift: permanent and shaft type	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Finishing Machine, Bidwell And Gamaco & Similar Equipment	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Forklift: 3000 lbs and over with attachments	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Forklifts: under 3000 lbs. with attachments	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Grade Engineer: Using Blue Prints, Cut Sheets, Etc	$93.71	**15J**	**11G**	**8X**

Power Equipment Operators- Underground Sewer & Water	Gradechecker/Stakeman	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Guardrail Punch	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Hard Tail End Dump Articulating Off- Road Equipment 45 Yards. & Over	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Hard Tail End Dump Articulating Off-road Equipment Under 45 Yards	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Horizontal/Directional Drill Locator	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Horizontal/Directional Drill Operator	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Hydralifts/boom trucks: 10 tons and under	$90.77	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Hydralifts/boom trucks: over 10 tons	$94.93	**7A**	**11H**	**8X**
Power Equipment Operators- Underground	Leverman	$96.49	**15J**	**11G**	**8X**

Sewer & Water					
Power Equipment Operators- Underground Sewer & Water	Loader, Overhead, 6 Yards. But Not Including 8 Yards	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Loaders, Overhead Under 6 Yards	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Loaders, Plant Feed	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Loaders: Elevating Type Belt	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Locomotives, All	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Material Transfer Device	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Mechanics: All (Leadmen - $0.50 per hour over mechanic)	$95.53	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Motor Patrol Graders	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground	Mucking Machine, Mole, Tunnel Drill, Boring, Road	$94.54	**15J**	**11G**	**8X**

Sewer & Water	Header And/or Shield				
Power Equipment Operators- Underground Sewer & Water	Oil Distributors, Blower Distribution & Mulch Seeding Operator	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Outside Hoists (Elevators and Manlifts), Air Tuggers, Strato	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Overhead, bridge type Crane: 20 tons through 44 tons	$95.64	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Overhead, bridge type: 100 tons and over	$97.46	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Overhead, bridge type: 45 tons through 99 tons	$96.51	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Pavement Breaker	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Pile Driver (other Than Crane Mount)	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Plant Oiler - Asphalt, Crusher	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground	Posthole Digger, Mechanical	$88.90	**15J**	**11G**	**8X**

Sewer & Water					
Power Equipment Operators- Underground Sewer & Water	Power Plant	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Pumps - Water	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Quad 9, Hd 41, D10 And Over	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Quick tower: no cab, under 100 feet in height base to boom	$94.93	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Remote Control Operator On Rubber Tired Earth Moving Equipment	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Rigger and Bellman	$90.77	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Rigger/Signal Person, Bellman(Certified)	$94.93	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Rollagon	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground	Roller, Other Than Plant Mix	$88.90	**15J**	**11G**	**8X**

Sewer & Water					
Power Equipment Operators- Underground Sewer & Water	Roller, Plant Mix Or Multi-lift Materials	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Roto-mill, Roto-grinder	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Saws - Concrete	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Scraper, Self Propelled Under 45 Yards	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Scrapers - Concrete & Carry All	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Scrapers, Self-propelled: 45 Yards And Over	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Shotcrete/Gunite Equipment	$88.90	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Shovel, Excavator, Backhoe, Tractors Under 15 Metric Tons	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground	Shovel, Excavator, Backhoe: Over 30 Metric	$94.54	**15J**	**11G**	**8X**

Sewer & Water	Tons To 50 Metric Tons				
Power Equipment Operators- Underground Sewer & Water	Shovel, Excavator, Backhoes, Tractors: 15 To 30 Metric Tons	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Shovel, Excavator, Backhoes: Over 50 Metric Tons To 90 Metric Tons	$95.53	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Shovel, Excavator, Backhoes: Over 90 Metric Tons	$96.49	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Slipform Pavers	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Spreader, Topsider & Screedman	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Subgrader Trimmer	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Tower Bucket Elevators	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Tower Crane: over 175' through 250' in height, base to boom	$98.47	**7A**	**11H**	**8X**
Power Equipment Operators- Underground	Tower crane: up to 175' in height base to boom	$97.46	**7A**	**11H**	**8X**

Sewer & Water					
Power Equipment Operators- Underground Sewer & Water	Tower Cranes: over 250' in height from base to boom	$99.42	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Transporters, All Track Or Truck Type	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Trenching Machines	$93.00	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Truck Crane Oiler/Driver: 100 tons and over	$95.64	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Truck crane oiler/driver: under 100 tons	$94.93	**7A**	**11H**	**8X**
Power Equipment Operators- Underground Sewer & Water	Truck Mount Portable Conveyor	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Vac Truck (Vactor Guzzler, Hydro Excavator)	$93.71	**15J**	**11G**	**8X**
Power Equipment Operators- Underground Sewer & Water	Welder	$94.54	**15J**	**11G**	**8X**
Power Equipment Operators- Underground	Wheel Tractors, Farmall Type	$88.90	**15J**	**11G**	**8X**

Sewer & Water					
Power Equipment Operators- Underground Sewer & Water	Yo Yo Pay Dozer	$93.71	**15J**	**11G**	**8X**
Power Line Clearance Tree Trimmers	Journey Level In Charge	$69.62	**5A**	**4A**	
Power Line Clearance Tree Trimmers	Spray Person	$65.89	**5A**	**4A**	
Power Line Clearance Tree Trimmers	Tree Equipment Operator	$69.62	**5A**	**4A**	
Power Line Clearance Tree Trimmers	Tree Trimmer	$62.19	**5A**	**4A**	
Power Line Clearance Tree Trimmers	Tree Trimmer Groundperson	$45.73	**5A**	**4A**	
Refrigeration & Air Conditioning Mechanics	Journey Level	$107.19	**6Z**	**1G**	
Residential Brick Mason	Journey Level	$82.00	**7E**	**1N**	
Residential Carpenters	Journey Level	$67.79		**1**	
Residential Cement Masons	Journey Level	$35.24		**1**	
Residential Drywall Applicators	Journey Level	$31.72		**1**	
Residential Drywall Tapers	Journey Level	$33.16		**1**	
Residential Electricians	Journey Level	$49.97	**7F**	**1D**	

Residential Glaziers	Journey Level	$21.22		**1**
Residential Insulation Applicators	Journey Level	$33.75		**1**
Residential Laborers	Journey Level	$28.59		**1**
Residential Marble Setters	Journey Level	$82.00	**7E**	**1N**
Residential Painters	Journey Level	$30.66		**1**
Residential Plumbers & Pipefitters	Journey Level	$40.83		**1**
Residential Refrigeration & Air Conditioning Mechanics	Journey Level	$61.75	**5A**	**1G**
Residential Sheet Metal Workers	Journey Level (Field or Shop)	$56.10	**7J**	**1I**
Residential Soft Floor Layers	Journey Level	$36.37		**1**
Residential Sprinkler Fitters (Fire Protection)	Journey Level	$19.32		**1**
Residential Stone Masons	Journey Level	$82.00	**7E**	**1N**
Residential Terrazzo Workers	Journey Level	$17.13		**1**
Residential Terrazzo/Tile Finishers	Journey Level	$18.09		**1**
Residential Tile Setters	Journey Level	$17.13		**1**

Roofers	Journey Level	$70.70	**5A**	**3H**
Roofers	Using Irritable Bituminous Materials	$74.15	**5A**	**3H**
Sheet Metal Workers	Journey Level (Field or Shop)	$103.56	**7F**	**1E**
Shipbuilding & Ship Repair	New Construction Boilermaker	$63.08	**7X**	**4J**
Shipbuilding & Ship Repair	New Construction Carpenter	$51.85	**7X**	**4J**
Shipbuilding & Ship Repair	New Construction Crane Operator	$44.29	**7V**	**1**
Shipbuilding & Ship Repair	New Construction Electrician	$63.26	**7X**	**4J**
Shipbuilding & Ship Repair	New Construction Heat & Frost Insulator	$100.83	**15H**	**11C**
Shipbuilding & Ship Repair	New Construction Laborer	$62.85	**7X**	**4J**
Shipbuilding & Ship Repair	New Construction Machinist	$63.08	**7X**	**4J**
Shipbuilding & Ship Repair	New Construction Operating Engineer	$44.29	**7V**	**1**
Shipbuilding & Ship Repair	New Construction Painter	$62.94	**7X**	**4J**
Shipbuilding & Ship Repair	New Construction Pipefitter	$64.14	**7X**	**4J**

Shipbuilding & Ship Repair	New Construction Rigger	$63.08	**7X**	**4J**
Shipbuilding & Ship Repair	New Construction Sheet Metal	$63.02	**7X**	**4J**
Shipbuilding & Ship Repair	New Construction Shipwright	$51.85	**7X**	**4J**
Shipbuilding & Ship Repair	New Construction Warehouse/Teamster	$44.29	**7V**	**1**
Shipbuilding & Ship Repair	New Construction Welder / Burner	$63.08	**7X**	**4J**
Shipbuilding & Ship Repair	Ship Repair Boilermaker	$63.08	**7X**	**4J**
Shipbuilding & Ship Repair	Ship Repair Carpenter	$51.85	**7X**	**4J**
Shipbuilding & Ship Repair	Ship Repair Crane Operator	$45.06	**7Y**	**4K**
Shipbuilding & Ship Repair	Ship Repair Electrician	$63.26	**7X**	**4J**
Shipbuilding & Ship Repair	Ship Repair Heat & Frost Insulator	$100.83	**15H**	**11C**
Shipbuilding & Ship Repair	Ship Repair Laborer	$62.85	**7X**	**4J**
Shipbuilding & Ship Repair	Ship Repair Machinist	$63.08	**7X**	**4J**
Shipbuilding & Ship Repair	Ship Repair Operating Engineer	$45.06	**7Y**	**4K**
Shipbuilding & Ship Repair	Ship Repair Painter	$62.94	**7X**	**4J**
Shipbuilding & Ship Repair	Ship Repair Pipefitter	$64.14	**7X**	**4J**

Shipbuilding & Ship Repair	Ship Repair Rigger	$63.08	**7X**	**4J**	
Shipbuilding & Ship Repair	Ship Repair Sheet Metal	$63.02	**7X**	**4J**	
Shipbuilding & Ship Repair	Ship Repair Shipwright	$51.85	**7X**	**4J**	
Shipbuilding & Ship Repair	Ship Repair Warehouse / Teamster	$45.06	**7Y**	**4K**	
Sign Makers & Installers (Electrical)	Journey Level	$17.13		**1**	
Sign Makers & Installers (Non-Electrical)	Journey Level	$17.13		**1**	
Soft Floor Layers	Journey Level	$70.17	**15J**	**4C**	
Solar Controls For Windows	Journey Level	$17.13		**1**	
Sprinkler Fitters (Fire Protection)	Journey Level	$83.61	**7J**	**1R**	
Stage Rigging Mechanics (Non Structural)	Journey Level	$17.13		**1**	
Stone Masons	Journey Level	$82.00	**7E**	**1N**	
Street And Parking Lot Sweeper Workers	Journey Level	$17.13		**1**	
Surveyors	Assistant Construction Site Surveyor	$94.93	**7A**	**11H**	**8X**
Surveyors	Chainman	$90.77	**7A**	**11H**	**8X**

Surveyors	Construction Site Surveyor	$96.51	**7A**	**11H**	**8X**
Surveyors	Drone Operator (when used in conjunction with survey work only)	$90.77	**7A**	**11H**	**8X**
Surveyors	Ground Penetrating Radar Operator	$90.77	**7A**	**11H**	**8X**
Telecommunication Technicians	Telecom Technician Journey Level	$65.58	**5B**	**1B**	
Telephone Line Construction - Outside	Cable Splicer	$42.62	**5A**	**2B**	
Telephone Line Construction - Outside	Hole Digger/Ground Person	$27.97	**5A**	**2B**	
Telephone Line Construction - Outside	Telephone Equipment Operator (Light)	$35.60	**5A**	**2B**	
Telephone Line Construction - Outside	Telephone Lineperson	$40.28	**5A**	**2B**	
Terrazzo Workers	Journey Level	$73.71	**7E**	**1N**	
Tile Setters	Journey Level	$71.71	**7E**	**1N**	
Tile, Marble & Terrazzo Finishers	Finisher	$62.54	**7E**	**1N**	
Traffic Control Stripers	All cleanup required in connection with traffic control stripers work (Group 1)	$98.49	**15L**	**1K**	

Traffic Control Stripers	Handling, painting and installing of all car stops, stop signs and any other type sign (Group 2)	$62.69	**15L**	**1K**
Traffic Control Stripers	Installation of guard rail and posts and similar protective devices (Group 2)	$62.69	**15L**	**1K**
Traffic Control Stripers	Installation of parking gates, ticket spitters and other mechanical and automatic control devices (Group 2)	$62.69	**15L**	**1K**
Traffic Control Stripers	Installation of plastic metal or composition button, or lines used instead of paint (Group 1)	$98.49	**15L**	**1K**
Traffic Control Stripers	Line removal; chemical sand and hydro-blast, paint and button (Group 1)	$98.49	**15L**	**1K**
Traffic Control Stripers	Manufacturing and installation of all car stops and control devices and similar traffic regulators (Group 2)	$62.69	**15L**	**1K**
Traffic Control Stripers	Manufacturing, painting, stenciling, servicing, repairing, placing and removal of traffic safety	$62.69	**15L**	**1K**

	and control devices/barricades (Group 2)				
Traffic Control Stripers	Painting and installing lines, arrows, bumpers, curbs, etc., on parking lots, air fields, highways, game courts (Group 1)	$98.49	**15L**	**1K**	
Traffic Control Stripers	Preparation and maintenance of all surfaces (Group 1)	$98.49	**15L**	**1K**	
Traffic Control Stripers	Seal coating, slurry coating and other surface protection (Group 2)	$62.69	**15L**	**1K**	
Truck Drivers	Asphalt Mix Over 16 Yards	$86.20	**15J**	**11M**	**8L**
Truck Drivers	Asphalt Mix To 16 Yards	$85.36	**15J**	**11M**	**8L**
Truck Drivers	Dump Truck	$85.36	**15J**	**11M**	**8L**
Truck Drivers	Dump Truck & Trailer	$86.20	**15J**	**11M**	**8L**
Truck Drivers	Other Trucks	$86.20	**15J**	**11M**	**8L**
Truck Drivers - Ready Mix	Transit Mix	$86.20	**15J**	**11M**	**8L**
Well Drillers & Irrigation Pump Installers	Irrigation Pump Installer	$17.13		**1**	
Well Drillers & Irrigation Pump Installers	Oiler	$17.13		**1**	

Well Drillers & Irrigation Pump Installers	Well Driller	$18.02	**1**

APPENDIX B:
PROJECT PERMITS
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

The following Permits are applicable to this project. All costs to obtain and comply with the listed permits and any additional permits shall be incidental to the contract. Reference Special Provision 1-07.6 for additional information.

Appendix B.1: Building Permit BLD2025-0832
Appendix B.2: Demolition Permit BLD2025-0833
Appendix B.3: Mechanical Permit MEC2025-0796
Appendix B.4: Plumbing Permit PLM2025-0426
Appendix B.5: Special Inspection and Testing Agreement
Appendix B.6: SEPA Determination of Non-Significance SEP2025-0021/SHR2025-0015
- B.6 Exhibit B: Geotechnical Design Services report, GeoEngineers 12/19/2024
- B.6 Exhibit C: Stormwater Engineering Report, Wilson Engineering 10/7/2024
- B.6 Exhibit E: Post Point Heron Colony Management Recommendations Update 2019

Appendix B.7: Shoreline Permit Exemption Authorization SHR2025-0015
Appendix B.8: NWCAA Order of Approval to Construct OAC 1437
Appendix B.9: NWCAA Asbestos/Demolition Notification Approval
- B.9 Exhibit A: Asbestos Containing Material and Lead Based Paint Survey Reports, All4 Inc., 3/5/2025 & 3/21/2025

Appendix B.10: Industrial Stormwater General Permit

APPENDIX B.1:
BUILDING PERMIT BLD2025-0832
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: BLD2025-0832

BUILDING NONRESIDENTIAL
TENANT IMPROVEMENT

DESCRIPTION: **REPLACE (E) 80K GAL SLUDGE TANK W/2 (N) 50K GAL TANKS - COB**

SCOPE OF WORK: **REPLACE EXISTING 80,000 GALLON SLUDGE TANK AT WASTE FACILITY WITH TWO NEW TANKS TOTALLING 100, 000 GALLON CAPACITY, WITH ACCOMPANYING INFRASTRUCTURE. ELECTRICAL PERMIT TO BE SUBMITTED SEPARATELY. SEPA AND SHORELINE PROCESS CONCURRENTLY.**

APPLICANT

STEPHEN DAY
CITY OF BELLINGHAM PUBLIC WORKS
2221 PACIFIC ST
BELLINHAM, WA 98229
PHONE: **(360)778-7944**
Email: **SMDAY@COB.ORG**
LIC #:

BUSINESS/TENANT

CITY OF BELLINGHAM PUBLIC WORKS
STEPHEN DAY
2221 PACIFIC ST
BELLINGHAM, WA 98229
PHONE: **(360)778-7944**
Email: **SMDAY@COB.ORG**
LIC #:

CONTRACTOR

TBD

,

PHONE:

PROJECT VALUATION	**$2,360,000.00**
MANUAL VALUATION	$2,360,000.00

SPRINKLED	**NFPA13**
OCCUPANCY REQ?	**No**

CONST TYPE	OCC GROUP	OCC LOAD	NEW AREA	EXIST AREA	NOTES
VB	**F-1**	**3**	**0**	**653**	**AREA 420 SLUDGE PUMP ROOM**
VB	**F-1**	**2**	**0**	**353**	**AREA 420 ELECTRICAL ROOM**
VB	**S-1**	**0**	**0**	**358**	**AREA 420 STORAGE ROOM**

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: BLD2025-0832

BUILDING NONRESIDENTIAL
TENANT IMPROVEMENT

Email: LIC #:
INVOICED
CITY OF BELLINGHAM PUBLIC WORKS **,** PHONE: Email: LIC #:
LENDER
TBD **,** PHONE: Email: LIC #:
OWNER
CITY OF BELLINGHAM FINANCE DEPT **ASSET DIVISION** **210 LOTTIE ST** **BELLINGHAM, WA 98225-4009** PHONE: Email: LIC #:

CONDITIONS

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
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City of Bellingham
City Hall - 210 Lottie Street
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Phone: (360) 778-8300
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LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: BLD2025-0832

BUILDING NONRESIDENTIAL
TENANT IMPROVEMENT

REQ PRIOR TO FINAL
CCI - CROSS CONNECTIONS: All cross connections and possible cross connections shall be protected by approved backflow methods according to WAC 246-290-490, The PNWS- AWWA Cross Connection Control Manual, the 2021 Uniform Plumbing Code and BMC 15.08.260. This includes all fixtures identified on the plans submitted for permit issuance. Any equipment or water uses not submitted in plan review will be assessed during inspections with backflow requirements set at that time. Contact the Cross Connection Control Specialist at 360-778-7700 for more information.

REQ PRIOR TO FINAL
CERTIFICATE OF OCCUPANCY REQUIRED: FOR ELECTRICAL ROOM AND SLUDGE PUMP ROOM CHANGE OF OCCUPANCY.

REQ PRIOR TO FINAL
CERTIFICATE OF OCCUPANCY REQUIRED: No building, or space, shall be used or occupied until a Certificate of Occupancy has been issued and inspected; See Bellingham Municipal Code 17.10.020 Section 110.

REQ PRIOR TO FINAL
CONTRACTOR SELECTION: Once the contractor has been selected, contact Building Services (permits@cob.org or #360-778-8300) with the name, address, phone number, and state contractor's license number and expiration date. The contractor must be selected prior to the preconstruction conference being conducted, or the first inspection.

REQ PRIOR TO FINAL
CONTRACTOR SELECTION: REQUIRED AFTER SELECTION BEFORE CONSTRUCTION

REQ PRIOR TO FINAL
CUSTOM CONDITION: FIRE DEPT. CONNECTION (FDC)

shall be updated with permanent signage, RED background WHITE lettering, min. 1" stroke defining what buildings or areas are served by fire sprinklers. This signage shall be replicated in the appropriate fire sprinkler riser room(s).

All NFPA 704 and any required Hazard signage shall be updated to reflect current operations.

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: BLD2025-0832

BUILDING NONRESIDENTIAL
TENANT IMPROVEMENT

REQ PRIOR TO FINAL
DEFERRED SUBMITTALS: Deferred submittals shall include the Permit Revision Amendment or Deferred Submittal Cover Sheet https://cob.org/wp-content/uploads/002-plan-amendment.pdf and be submitted to the Permit Center permits@cob.org and in accordance with the IBC & BMC. Submittal documents for deferred submittal items shall first be submitted to the architect or engineer of record who shall review them prior to the Building Official review with a notation indicating that the deferred submittal documents have been reviewed and that they have been found to be in general conformance with the design of the structure. The deferred submittal item shall not be installed until their design and submittal documents have been approved by the Building Official.

REQ PRIOR TO FINAL
DEFERRED SUBMITTALS: EXCAVATION SUPPORTS, HANDRAILS GUARDRAILS AND GRATING, CONCRETE MIX DESIGN AND TEST RESULTS, AUGERED PILES, FLOOR ACCESS DOORS, MONORAIL SYSTEM, PIPE SUPPORT SYSTEM DESIGN AND ANCHORAGE.

REQ PRIOR TO FINAL
SPECIAL INSPECTION REQUIRED: Provide completed and signed Special Inspection and Testing Agreement form prior to issuance. https://cob.org/wp-content/uploads/021-special-inspection.pdf

REQ PRIOR TO FINAL
SPECIAL INSPECTION REQUIRED: SITA REQUIRED AT PRE-CON PRIOR TO START OF CONSTRUCTION.

INFORMATIONAL
APPROVED SUBJECT TO FIELD INSPECTION: This permit is issued subject-to-field-inspections and approvals.

INFORMATIONAL
CUSTOM CONDITION: The applicant shall be required to comply with the Northwest Clean Air Agency conditions of approval associated with the Order of Approval to Construct OAC 1437 in Attachments.

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: BLD2025-0832

BUILDING NONRESIDENTIAL
TENANT IMPROVEMENT

INFORMATIONAL
CUSTOM CONDITION: The applicant shall be required to prioritize timing of the proposed construction outside of the critical January 15 to September 1 timeframe to minimize impacts to the heron colony as recommended in the Post Point Heron Colony Management Plan prepared by Nahkeeta in 2019 to the extent reasonably practical.
Construction noise including use of temporary and permanent generators shall not exceed the 92 dB thresholds as recommended in the Post Point Heron Colony Management Plan prepared by Nahkeeta in 2019.
Exterior lighting associated with temporary and permanent construction shall be directed away from the heron colony as recommended in the Post Point Heron Colony Management Plan prepared by Nahkeeta in 2019. Additionally, the placement of temporary generators shall be located to minimize noise impacts on the heron colony to the extent reasonably practical.

INFORMATIONAL
ELECTRICAL PERMIT REQUIRED: A separate electrical permit is required before the installation of any electrical equipment or wiring. A separate permit is required for each entity performing electrical work. City electrical permits may be applied for online at https://www.cob.org/epermits.

INFORMATIONAL
EQUIPMENT AND APPLIANCE INSTALLATION: Equipment and appliances shall be installed as required by the terms of their approval, in accordance with the conditions of listing, the manufacturers instructions and this code. Manufacturers installation instructions shall be available on the job site at the time of inspection.

INFORMATIONAL
LENDER INFORMATION: LENDER INFORMATION

For questions regarding this project, your contact in The Permit Center is:
Name: **SUSANNA HANDOW** Phone: **(360)778-8370** Email: **SDHANDOW@COB.ORG**

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

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City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: BLD2025-0832

BUILDING NONRESIDENTIAL
TENANT IMPROVEMENT

INSPECTION LINE:
(360) 778-8303
INSPECTION WEB SITE:
www.cob.org/epermits

INSPECTION	INSPECTION CODE	APPROVED DATE	INSPECTOR
PRE-CONSTRUCTION MTG	402		
TEMP EROSION CONTROL	205		
FOOTING	410		
PILE CAPS	412		
GRADE BEAMS	413		
FOUNDATION WALLS	415		
UNDERGRND INSULATION	417		
STRUCTURAL SLAB	420		
INSTALLATION STORM	522		
ONSITE FACILITIES	230		
SHEAR NAILING	435		
SITE STABILIZATION	235		
ROOF SHEATHING	436		
FRAMING	450		
MASONRY	451		

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

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7/30/2028

PERMIT #: BLD2025-0832

BUILDING NONRESIDENTIAL
TENANT IMPROVEMENT

STRUCTURAL STEEL	452		
TILT UP WALL PANEL	453		
CON OR MAS COLUM	454		
INSULATION	455		
DRYWALL NAILING	456		
SUSPENDED CEILING	475		
CROSS-CONNECTION	580		
FINAL - FIRE	790		
FINAL - PARKS	890		
FINAL - PLANNING	690		
FINAL - STORMWATER	290		
FINAL - BUILDING	495		
OTHER	498		

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

APPENDIX B.2:
DEMOLITION PERMIT BLD2025-0833
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
8/31/2026
EXPIRATION DATE:
8/30/2028

PERMIT #: BLD2025-0833

DEMOLITION
PARTIAL OR INTERIOR

DESCRIPTION: **REPLACE (E) 80K GAL SLUDGE TANK W/2 (N) 50K GAL TANKS - COB**

SCOPE OF WORK: **DEMO EXISTING 80,000 GALLON SLUDGE TANK AT AREA 420 CHLORINE BUILDING AND ASSOCIATED EQUIPMENT.**

APPLICANT
STEPHEN DAY **CITY OF BELLINGHAM PUBLIC WORKS** **2221 PACIFIC ST** **BELLINHAM, WA 98229** PHONE: **(360)778-7944** Email: **SMDAY@COB.ORG** LIC #:
CONTRACTOR
TBD **,** PHONE: Email: LIC #:
ENGINEER OF RECORD
MATT SPRICK, PE **CAROLLO ENGINEERS** **,** PHONE: **(615)450-9132** Email: **MSPRICK@CAROLLO.COM** LIC #:

PROJECT VALUATION	**$113,370.00**
MANUAL VALUATION	$113,370.00

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
8/31/2026
EXPIRATION DATE:
8/30/2028

PERMIT #: BLD2025-0833

DEMOLITION
PARTIAL OR INTERIOR

INVOICED
CITY OF BELLINGHAM PUBLIC WORKS , PHONE: Email: LIC #:
OWNER
CITY OF BELLINGHAM FINANCE DEPT **ASSET DIVISION** **210 LOTTIE ST** **BELLINGHAM, WA 98225-4009** PHONE: Email: LIC #:

CONDITIONS

REQ PRIOR TO FINAL
CCI - CROSS CONNECTIONS: All cross connections and possible cross connections shall be protected by approved backflow methods according to WAC 246-290-490, The PNWS- AWWA Cross Connection Control Manual, the 2021 Uniform Plumbing Code and BMC 15.08.260. This includes all fixtures identified on the plans submitted for permit issuance. Any equipment or water uses not submitted in plan review will be assessed during inspections with backflow requirements set at that time. Contact the Cross Connection Control Specialist at 360-778-7700 for more information.

INFORMATIONAL
APPROVED SUBJECT TO FIELD INSPECTION: This permit is issued subject-to-field-inspections and approvals.

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
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8/31/2026
EXPIRATION DATE:
8/30/2028

PERMIT #: BLD2025-0833

DEMOLITION
PARTIAL OR INTERIOR

INFORMATIONAL
CONTRACTOR SELECTION: Once the contractor has been selected, contact Building Services (permits@cob.org or #360-778-8300) with the name, address, phone number, and state contractor's license number and expiration date. The contractor must be selected prior to the preconstruction conference being conducted, or the first inspection.

INFORMATIONAL
CUSTOM CONDITION: Note: An appeal of the land use decisions has been submitted by an appellant. Legal staff representing the planning staff submitted a motion for the Hearing Examiner to dismiss the appeal. As of 2/23/26 the Hearing Examiner has not made a decision on the motion to dismiss the appeal. Pursuance of construction permits and/or associated construction activity prior to a formal determination on the appeal are at the applicants own risk.

INFORMATIONAL
CUSTOM CONDITION: The applicant shall be required to prioritize timing of the proposed construction outside of the critical January 15 to September 1 timeframe to minimize impacts to the heron colony as recommended in the Post Point Heron Colony Management Plan prepared by Nahkeeta in 2019 to the extent reasonably practical.
Construction noise including use of temporary and permanent generators shall not exceed the 92 dB thresholds as recommended in the Post Point Heron Colony Management Plan prepared by Nahkeeta in 2019.
Exterior lighting associated with temporary and permanent construction shall be directed away from the heron colony as recommended in the Post Point Heron Colony Management Plan prepared by Nahkeeta in 2019. Additionally, the placement of temporary generators shall be located to minimize noise impacts on the heron colony to the extent reasonably practical.

INFORMATIONAL
DEMO-FLOORS/FOUNDATIONS: All concrete or masonry floors, foundations, footings, basement walls and retaining walls shall be removed to 18 inches below ground (final grade).

All concrete floors left in place shall allow water to drain through. Holes may be filled with soil, concrete or rocks no larger than 12 inches in diameter. Wood and other organic materials are not allowed.

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

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E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
8/31/2026
EXPIRATION DATE:
8/30/2028

PERMIT #: BLD2025-0833

DEMOLITION
PARTIAL OR INTERIOR

INFORMATIONAL
DEMOLITION REQUIREMENTS: Contact Utilities Underground Location Center 1-800-424-5555 at least 2 business days before excavation.
Contact private utility companies if their services are to be interrupted or disconnected.
Contact Whatcom County Health Department 360-676-6724 if demolition site is served by a septic system.
NOTIFICATION of DEMOLITION from Northwest Clean Air Agency must be submitted to NWCAA and approval obtained PRIOR to commencing demolitions and/or asbestos projects.
Contact the Fire Department at 360-778-8400 for questions regarding hazardous materials or underground fuel storage tanks.

INFORMATIONAL
DEMOLITION REQUIREMENTS: Contact Utilities Underground Location Center 1-800-424-5555 at least 2 business days before excavation.
Contact private utility companies if their services are to be interrupted or disconnected.
Contact Whatcom County Health Department 360-676-6724 if demolition site is served by a septic system.
NOTIFICATION of DEMOLITION from Northwest Clean Air Agency must be submitted to NWCAA and approval obtained PRIOR to commencing demolitions and/or asbestos projects.
Contact the Fire Department at 360-778-8400 for questions regarding hazardous materials or underground fuel storage tanks.

INFORMATIONAL
LEAD PAINT PROGRAM: Contact the Washington State Department of Commerce Lead Paint Program at 360.586.5323 (LEAD) and/or visit www.commerce.wa.gov/lead or email the lead program lbpinfo@commerce.wa.gov before renovating or remodeling activities in pre-1978 residential buildings or child occupied facilities to ensure compliance with applicable lead regulations.

INFORMATIONAL
LEAD PAINT PROGRAM: Contact the Washington State Department of Commerce Lead Paint Program at 360.586.5323 (LEAD) and/or visit www.commerce.wa.gov/lead or email the lead program lbpinfo@commerce.wa.gov before renovating or remodeling activities in pre-1978 residential buildings or child occupied facilities to ensure compliance with applicable lead regulations.

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

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Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
8/31/2026
EXPIRATION DATE:
8/30/2028

PERMIT #: BLD2025-0833

DEMOLITION
PARTIAL OR INTERIOR

For questions regarding this project, your contact in The Permit Center is:
Name: **SUSANNA HANDOW** Phone: **(360)778-8370** Email: **SDHANDOW@COB.ORG**

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

City of Bellingham
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Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
8/31/2026
EXPIRATION DATE:
8/30/2028

PERMIT #: BLD2025-0833

DEMOLITION
PARTIAL OR INTERIOR

INSPECTION LINE:
(360) 778-8303
INSPECTION WEB SITE:
www.cob.org/epermits

INSPECTION	INSPECTION CODE	APPROVED DATE	INSPECTOR
PRE-CONSTRUCTION MTG	402		
TEMP EROSION CONTROL	205		
CROSS-CONNECTION	580		
FINAL - STORMWATER	290		
FINAL - BUILDING	495		

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

APPENDIX B.3:
MECHANICAL PERMIT MEC2025-0796
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: MEC2025-0796

MECHANICAL
NEW OR ALTERED SYSTEMS

DESCRIPTION: **REPLACE (E) 80K GAL SLUDGE TANK W/2 (N) 50K GAL TANKS - COB**

SCOPE OF WORK: **REPLACE EXISTING 80,000 GALLON SLUDGE TANK AT WASTE FACILITY WITH TWO NEW TANKS TOTALLING 100, 000 GALLON CAPACITY, WITH ACCOMPANYING INFRASTRUCTURE. ELECTRICAL PERMIT TO BE SUBMITTED SEPARATELY. SEPA AND SHORELINE PROCESS CONCURRENTLY.**

APPLICANT
STEPHEN DAY **CITY OF BELLINGHAM PUBLIC WORKS** **2221 PACIFIC ST** **BELLINHAM, WA 98229** PHONE: **(360)778-7944** Email: **SMDAY@COB.ORG** LIC #:
MECHANICAL CONTRACTOR
TBD **,** PHONE: Email: LIC #:
OWNER
CITY OF BELLINGHAM FINANCE DEPT **ASSET DIVISION** **210 LOTTIE ST** **BELLINGHAM, WA 98225-4009** PHONE:

PROJECT VALUATION	**$0.00**

MECHANICAL FIXTURES	COUNT
A/C,HeatPump=or<15HP/ton	2
Exhaust Fan	3
Unit Heater	1

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: MEC2025-0796

MECHANICAL
NEW OR ALTERED SYSTEMS

Email:
LIC #:

CONDITIONS

INFORMATIONAL
APPROVED SUBJECT TO FIELD INSPECTION: This permit is issued subject-to-field-inspections and approvals.

INFORMATIONAL
COMMISSIONING PLAN REQUIRED: A commissioning plan is required prior to permit issuance pursuant to Washington State Energy Code (WSEC) Section 408.1. The plan must be developed by the project's certified commissioning professional (CCP) and shall outline the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. The CCP must be an individual who is certified by an ANSI/ISO/IEC 17024:2012 accredited organization to lead, plan, coordinate, and manage commissioning teams and implement the commissioning process. For more information on the Commissioning Plan requirements, see WSEC Section C408.1: https://up.codes/viewer/washington/wa-energy-code-commercial-provisions-2018/chapter/CE_4/ce-commercial-energy-efficiency#C408.1.

INFORMATIONAL
CONTRACTOR SELECTION: Once the contractor has been selected, contact Building Services (permits@cob.org or #360-778-8300) with the name, address, phone number, and state contractor's license number and expiration date. The contractor must be selected prior to the preconstruction conference being conducted, or the first inspection.

INFORMATIONAL
CONTRACTOR SELECTION: Once the contractor has been selected, contact Building Services (permits@cob.org or #360-778-8300) with the name, address, phone number, and state contractor's license number and expiration date. The contractor must be selected prior to the preconstruction conference being conducted, or the first inspection.

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: MEC2025-0796

MECHANICAL
NEW OR ALTERED SYSTEMS

INFORMATIONAL
ELECTRICAL PERMIT REQUIRED: A separate electrical permit is required before the installation of any electrical equipment or wiring. A separate permit is required for each entity performing electrical work. City electrical permits may be applied for online at https://www.cob.org/epermits.

For questions regarding this project, your contact in The Permit Center is:
Name: **SUSANNA HANDOW** Phone: **(360)778-8370** Email: **SDHANDOW@COB.ORG**

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
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City Hall - 210 Lottie Street
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LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: MEC2025-0796

MECHANICAL
NEW OR ALTERED SYSTEMS

INSPECTION LINE:
(360) 778-8303
INSPECTION WEB SITE:
www.cob.org/epermits

INSPECTION	INSPECTION CODE	APPROVED DATE	INSPECTOR
PRE-CONSTRUCTION MTG	402		
ROUGH - MECHANICAL	441		
GAS PIPING/PRESSURE	442		
FINAL - MECHANICAL	489		

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

APPENDIX B.4:
PLUMBING PERMIT PLM2025-0426
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: PLM2025-0426

PLUMBING NONRESIDENTIAL
NEW FIXTURES

DESCRIPTION: **REPLACE (E) 80K GAL SLUDGE TANK W/2 (N) 50K GAL TANKS - COB**

SCOPE OF WORK: **REPLACE EXISTING 80,000 GALLON SLUDGE TANK AT WASTE FACILITY WITH TWO NEW TANKS TOTALLING 100, 000 GALLON CAPACITY, WITH ACCOMPANYING INFRASTRUCTURE. ELECTRICAL PERMIT TO BE SUBMITTED SEPARATELY. SEPA AND SHORELINE PROCESS CONCURRENTLY.**

APPLICANT
STEPHEN DAY **CITY OF BELLINGHAM PUBLIC WORKS** **2221 PACIFIC ST** **BELLINHAM, WA 98229** PHONE: **(360)778-7944** Email: **SMDAY@COB.ORG** LIC #:
OWNER
CITY OF BELLINGHAM FINANCE DEPT **ASSET DIVISION** **210 LOTTIE ST** **BELLINGHAM, WA 98225-4009** PHONE: Email: LIC #:
PLUMBING CONTRACTOR
TBD , PHONE:

PROJECT VALUATION	**$0.00**

PLUMBING FIXTURES	COUNT
Hose Bibb	2
Water Heater - Electric	1

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

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E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: PLM2025-0426

PLUMBING NONRESIDENTIAL
NEW FIXTURES

Email:
LIC #:

CONDITIONS

REQ PRIOR TO ISSUE
CONTRACTOR SELECTION: Once the contractor has been selected, contact Building Services (permits@cob.org or #360-778-8300) with the name, address, phone number, and state contractor's license number and expiration date. The contractor must be selected prior to the preconstruction conference being conducted, or the first inspection.

INFORMATIONAL
APPROVED SUBJECT TO FIELD INSPECTION: This permit is issued subject-to-field-inspections and approvals.

INFORMATIONAL
CONTRACTOR SELECTION: Once the contractor has been selected, contact Building Services (permits@cob.org or #360-778-8300) with the name, address, phone number, and state contractor's license number and expiration date. The contractor must be selected prior to the preconstruction conference being conducted, or the first inspection.

For questions regarding this project, your contact in The Permit Center is:
Name: **SUSANNA HANDOW** Phone: **(360)778-8370** Email: **SDHANDOW@COB.ORG**

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

City of Bellingham
City Hall - 210 Lottie Street
Bellingham, WA 98225
Phone: (360) 778-8300
Fax: (360) 778-8301
E-MAIL: permits@cob.org

LOCATION:
200 MCKENZIE AVE
DATE ISSUED:
7/31/2026
EXPIRATION DATE:
7/30/2028

PERMIT #: PLM2025-0426

PLUMBING NONRESIDENTIAL
NEW FIXTURES

INSPECTION LINE:
(360) 778-8303
INSPECTION WEB SITE:
www.cob.org/epermits

INSPECTION	INSPECTION CODE	APPROVED DATE	INSPECTOR
PLUMBING GROUNDWORK			
PRE-CONSTRUCTION MTG	402		
ROUGH - PLUMBING	340		
FINAL - PLUMBING	390		

POST THIS PERMIT ONSITE WITH THE APPROVED PLANS

COMPLIANCE WITH ALL INSPECTIONS AND CONDITIONS REQUIRED PRIOR TO OCCUPANCY

ALL INSPECTIONS SHOULD BE SCHEDULED A MINIMUM OF 1 BUSINESS DAY IN ADVANCE
INSPECTION SCHEDULING INSTRUCTIONS
INSPECTION PHONE 360.778.8303 – 24 HOURS
WEB SCHEDULING WWW.COB.ORG/EPERMITS

APPENDIX B.5:
SPECIAL INSPECTION AND TESTING AGREEMENT
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

As per the requirements of the Building Permit(s), the attached Special Inspection and Testing Agreement will be completed by the Owner after the Contractor has been awarded the contract. The Contractor shall be responsible to schedule all required inspections with the Inspection Agency and City of Bellingham Permit Center as required by the applicable permits.

Public Works Department

To: Planning and Community Development Department
Planning and Development Services

Attn: Ryan O'Connor, Plans Examiner
Sean Angeley, Building Official

RE: BLD2025-0832 R3 Submittal- Special Inspection & Testing Agreement Status
Letter of Intent to Complete Agreement

Ryan:

The City of Bellingham Public Works Department submits this letter of intent in response to your Revision 2 comment regarding completion of the Special Inspection & Testing Agreement (SITA). With this R3 submittal, we include the partially completed SITA and this letter.

Due to municipal bidding requirements for Public Work, the SITA cannot be fully completed and signed until the project has been publicly bid and a responsible and responsive contractor has been issued a Notice to Proceed for construction. The Public Works Department has assigned Project Engineer and Construction Inspector staff to the project, and has contracted with Carollo Engineers to provide Construction Management services during construction. Carollo Engineers has subcontracted with Certerra (formerly GeoTest) to provide the required special inspection services outlined in the SITA.

The Public Works Department will ensure that all code-required special inspections occur on this project. We anticipate the completed SITA, signed by all required parties will be submitted shortly after Notice to Proceed is issued to the successful project contractor. Notice to Proceed is anticipated for the 4th quarter (Oct-Dec) of 2026, pending completion of the bidding and contracting process.

Please contact me with any questions regarding this project and permit.

Regards,

Stephen Day, Plants Engineer

Engineering · Internal Services · Operations · Natural Resources · Transportation
2221 Pacific Street - Bellingham, WA 98229
Phone: (360) 778-7700 - Fax: (360) 778-7701
Email: askpw@cob.org

Permit Center
210 Lottie Street, Bellingham, WA 98225
Phone: (360) 778-8300 Fax: (360) 778-8301 TTY: 711 (WA Relay)
Email: permits@cob.org Web: www.cob.org/permits

SPECIAL INSPECTION & TESTING AGREEMENT

1. Engineer or architect of record shall identify all special inspection requirements on the plans and specifications prior to submittal of plans for permit application. The engineer or architect of record shall respond to deficiencies identified by the Special Inspector, and submit remedial corrections, as required to all parties to this agreement.
2. The contractor or any persons performing the work shall not retain or compensate the special inspection firm.
3. All special inspection agencies and Special Inspectors must be certified under the WABO Special Inspector Certification program. The design professional that prepared the design may perform special inspections.
4. The Special Inspector is only allowed to inspect based upon plans which have been approved by the City. The contractor shall retain at the job site all records submitted by the Special Inspector, and provide these records to the building inspector as requested.
5. The Special Inspector shall perform all inspection and reporting duties as identified by the design professional, including:
   (a) Observe work, take samples
   (b) Retain daily reports at job site
   (c) Report non-compliance items
   (d) Furnish periodic reports to the Building Services as requested
   (e) Furnish final inspection reports
6. By completing this document it is acknowledged that special inspections do not supplant City of Bellingham inspection approvals and that special inspections are for purposes of reporting only. Special inspections do not carry authority to approve work.
7. Building Services Division shall approve all special inspection requirements prior to permit issuance. The designated BSD project inspector shall monitor the special inspection program and provide approval of activities and construction process. No Certificate of Occupancy or final inspection approval will be issued by BSD until all special inspection reports and final reports have been submitted and accepted.

ACKNOWLEDGEMENTS

The undersigned have read and agree to comply with the terms and conditions of this agreement.

PROJECT ADDRESS: 200 McKenzie Ave, Bellingham WA		**PERMIT NUMBER:** BLD2025-0832/33	
	COMPANY NAME	**PERSON APPROVING THIS AGREEMENT**	**DATE**
Owner	City of Bellingham	Stephen Day, Project Engineer	
Contractor			
Inspection Agency	Certerra (Geotest)		

PROJECT NAME: Post Point Resource Recovery Plant Sludge Tank Replacement Project

Types of inspections and tests to be performed.	PERIODIC	CONTINUOUS	IBC REFERENCE SECTION(S)
See attached specification tables for inspection references.			

ATTACHMENT A - CONCRETE - SPECIAL INSPECTION SCHEDULE

CONCRETE - SPECIAL INSPECTION SCHEDULE
(Includes: Cast-in-place, precast, prestressed, precast-prestressed, and shotcrete.)

Verification and Inspection	Reference Standard	Frequency of Inspection(1) (During Task Listed)	
		Continuous	Periodic
1. Inspect reinforcement, including prestressing tendons, and verify placement.	ACI 318 Building Code		●
2. Reinforcing bar welding:			
a. Verify weldability of reinforcing bars other than ASTM A706;	AWS D1.4 ACI 318		●
b. Inspect single-pass fillet welds, maximum 5/16 inch; and	AWS D1.4 ACI 318		●
c. Inspect all other welds.	AWS D1.4 ACI 318	●	
3. Inspect anchors cast in concrete.	ACI 318		●
4. Inspect anchors post-installed in hardened concrete members:			
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads.	ACI 318	●	
b. Mechanical anchors and adhesive anchors not defined in 4.a.	ACI 318		●
5. Verify use of required design mix.	ACI 318 Building Code		●
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	ASTM C172 ASTM C31 ACI 318 Building Code	●	
7. Inspect concrete and shotcrete placement for proper application techniques.	ACI 318 Building Code	●	
8. Verify maintenance of specified curing temperature and techniques.	ACI 318 Building Code		●
9. Inspect prestressed concrete for:			
a. Application of prestressing forces; and	ACI 318	N/A	N/A
b. Grouting of bonded prestressing tendons.	ACI 318	N/A	N/A
10. Inspect erection of precast concrete members.	ACI 318	N/A	N/A
11. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	ACI 318	N/A	N/A
12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	ACI 318		●

Notes:
(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT B - ARCHITECTURAL, MECHANICAL, AND ELECTRICAL COMPONENTS - SPECIAL INSPECTION SCHEDULE

ARCHITECTURAL, MECHANICAL, AND ELECTRICAL COMPONENTS - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
1. Architectural components:			
a. Cladding - exterior, weighing more than 5 psf: Erection and fastening.	Building Code	N/A	N/A
b. Exterior insulation and finish system (EIFS):	Building Code	N/A	N/A
c. Non-bearing walls - exterior: Erection and fastening.	Building Code	N/A	N/A
d. Non-bearing walls - interior, weighing more than 15 psf.	Building Code		●
e. Veneer, exterior and interior, weighing more than 5 psf: Erection and fastening.	Building Code	N/A	N/A
f. Access floors: Erection and anchorage.	Building Code		●
g. Suspended ceiling system: Bracing.		N/A	N/A
h. Storage racks - 8 feet or greater in height: Anchorage.	Building Code		●
i. Skylight: Verification of safety compliance and labeling and installation.	Building Code	N/A	N/A
2. Plumbing, mechanical, and electrical components:			
a. Anchorage of other electrical and mechanical equipment over 400 lb. on floors or roofs.	Building Code		●
b. Installation and anchorage of pipelines carrying hazardous chemicals and their associated mechanical units.	Building Code		●
c. Installation and anchorage of pipelines greater than 8 inches in diameter.			●
d. Installation and anchorage of ductwork designed to carry hazardous materials.	Building Code		●
e. Installation and anchorage of ductwork greater than 6 sf in cross section.			●
f. Installation and anchorage of vibration isolation systems where Contract Documents require nominal clearance of 1/4 inch or less between the equipment support frame and its support/restraint.	Building Code	N/A	N/A

Verification and Inspection	Reference Standard	Frequency of Inspection(1) (During Task Listed)	
		Continuous	Periodic
g. Installation of mechanical and electrical equipment, including duct work, piping systems and their structural supports, where automatic fire sprinkler systems are installed.	Building Code	N/A	N/A
3. Fire-resistance elements:			
a. Sprayed fire-resistant coatings:	Building Code	N/A	N/A
b. Mastic and intumescent coatings:	Building Code	N/A	N/A
c. Fire-resistant penetrations and joint systems:	Building Code	N/A	N/A
4. Smoke control systems;	Building Code	N/A	N/A
Notes: (1) "●" represents a required inspection activity for the project where it occurs.			

ATTACHMENT C- SOILS - SPECIAL INSPECTION SCHEDULE

SOILS - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	Building Code		●
2. Verify excavations are extended to proper depth and have reached proper material.	Building Code		●
3. Perform classification and testing of fill and backfill materials.	Building Code		●
4. Verify use of proper materials, densities, and lift thicknesses during placement and compaction of fill and backfill.	Building Code	●	
5. Prior to placement of fill, observe subgrade and verify that site has been prepared properly.	Building Code		●

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT D - STRUCTURAL STEEL WELDING - SPECIAL INSPECTION SCHEDULE

STRUCTURAL STEEL WELDING - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
Inspection Tasks Prior to Welding	AISC 360		
1. Welding procedure specifications (WPSs) available.		●	
2. Manufacturer certifications for welding consumables available.		●	
3. Material identification (type/grade).			●
4. Welder identification system.			●
5. Fit-up groove welds (including joint geometry): • Joint preparation. • Dimensions (alignment, root opening, root face, bevel). • Cleanliness (condition of steel surfaces). • Tacking (tack weld quality and location). • Backing type and fit (if applicable).			●
6. Configuration and finish of access holes.			●
7. Fit-up of fillet welds: • Dimensions (alignment, gaps at root). • Cleanliness (condition of steel surfaces). • Tacking (tack weld quality and location).			●
8. Check welding equipment.			●
Inspection Tasks During Welding	AISC 360		
9. Use of qualified welders.			●
10. Control and handling of welding consumables: • Packaging. • Exposure control.			●
11. No welding over cracked tack welds.			●
12. Environmental conditions: • Wind speed within limits. • Precipitation and temperature.			●
13. WPS followed: • Settings on welding equipment. • Travel speed. • Selected welding materials. • Shielding gas type/flow rate. • Preheat applied. • Interpass temperature maintained (min/max). • Proper position (F, V, H, OH).			●

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
14. Welding techniques: • Interpass and final cleaning. • Each pass within profile limitations. • Each pass meets quality requirements.			●
Inspection Tasks After Welding	AISC 360		
15. Welds cleaned.			●
16. Size, length, and location of welds.		●	
17. Welds meet visual acceptance criteria: • Crack prohibition. • Weld/base-metal fusion. • Crater cross section. • Weld profiles. • Weld size. • Undercut. • Porosity.		●	
18. Arc strikes.		●	
19. k-area.		●	
20. Backing removed and weld tabs removed (if required).		●	
21. Repair activities.		●	
22. Document acceptance or rejection of welded joint or member.		●	

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT E - STRUCTURAL STEEL BOLTING - SPECIAL INSPECTION SCHEDULE

STRUCTURAL STEEL BOLTING - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection(1) (During Task Listed)	
		Continuous	Periodic
Inspection Tasks Prior to Bolting	AISC 360		
1. Manufacturer's certifications available for fastener materials.		●	
2. Fasteners marked in accordance with ASTM requirements.			●
3. Proper fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane).			●
4. Proper bolting procedure selected for joint detail.			●
5. Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements.			●
6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used.			●
7. Proper storage provided for bolts, nuts, washers and other fastener components.			●
Inspection Tasks During Bolting	AISC 360		
8. Fastener assemblies, of suitable condition, placed in all holes and washers (if required) are positioned as required.			●
9. Joint brought to the snug-tight condition prior to the pretensioning operation.			●
10. Fastener component not turned by the wrench prevented from rotating.			●
11. Fasteners are pretensioned in accordance with the RCSC Specification, progressing systematically from the most rigid point toward the free edges.			●
Inspection Tasks After Bolting	AISC 360		
12. Document acceptance or rejection of bolted connections.		●	

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT F - DEEP FOUNDATIONS, CAST-IN-PLACE - SPECIAL INSPECTION SCHEDULE

DEEP FOUNDATIONS, CAST-IN-PLACE - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
1. Observe drilling operations and maintain complete and accurate records for each element.	Building Code	●	
2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock or specified stratum (if applicable), and adequate end-bearing strata capacity. Record concrete or grout volumes.	Building Code	●	
3. For concrete or grout installations, perform additional Special Inspection in accordance with Attachment A - Concrete Special Inspection.	Building Code	-	-

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

APPENDIX B.6:
SEPA DETERMINATION OF NON-SIGNIFICANCE SEP2025-0021/SHR2025-0015
POST POINT SLUDGE TANK REPLACEMENT PROJECT EU194

This Appendix includes the following select Exhibits from the SEPA DNS materials identified as relevant documents in Special Provision 1-07.6.:

B.6 Exhibit B: Geotechnical Design Services report, GeoEngineers 12/19/2024
B.6 Exhibit C: Stormwater Engineering Report, Wilson Engineering 10/7/2024
B.6 Exhibit E: Post Point Heron Colony Management Recommendations Update 2019

Planning and Community Development Department
210 Lottie Street, Bellingham, WA 98225
Phone: (360) 778-8300 Fax: (360) 778-8301 TTY: (360) 778-8382
Email: planning@cob.org Web: www.cob.org

Determination of Non-Significance (DNS)

SHR2025-0015 & SEP2025-0021

Date of Issuance of Threshold Determination: 12/17/2025

Project Name: Post Point Resource Recovery Plant Primary Sludge Tank Replacement Project

Project Description: Construction of a new and similar sized set of tanks and associated infrastructure within the existing wastewater plant boundary to replace the existing tank and restore operational reliability. Proposed project elements include the following: Demolition of the abandoned Chlorine Building 420; Construction of two new 50,000 gallon concrete tanks and a biotrickling filter/odor control system in the approximate location of the Chlorine Building 420; Site restoration/stormwater/yard piping around the new sludge storage tanks and odor control; Repurpose the existing Chlorine Scrubber Building to support the new mechanical and electrical infrastructure associated with the new sludge storage tanks; Structural modifications include adding exterior doors, extending the grade-level floor across the building and roof material replacement; Demolition of the existing sludge storage tank inside Building 510; Replacement of thickened sludge pumps and associated piping inside the Building 530 basement; Demolition of existing waste activated sludge pumps and addition of a new dewatering pump inside the Building 340 basement; Replacement of two existing return activated sludge pumps and piping; Piping modifications between the new sludge storage tanks and the secondary pump station; and Construction of new replacement waste activated sludge pumps.

Project Location: 200 McKenzie Ave., Bellingham WA 98225 Fairhaven Urban Village, Public 2 zoning Pacel Number(s) 370211-403538 & 370202-452038

Proponent: Stephen Day P.E., S.E. City of Bellingham Project Engineer – Plants, 104 W. Magnolia St. Suite 109, Bellingham WA 98225

Lead Agency: City of Bellingham, Planning and Community Development Department (PCDD)

Environmental Information Considered: Post Point Resource Recovery Plant Primary Sludge Tank Replacement Project – Cultural Resources Assessment (ESA 2025); Geotechnical Design Services for the Post Point Primary Sludge Tank Replacement (GeoEngineers 2024); Post Point Primary Sludge Tank Replacement Project Draft Stormwater Engineering Report (Wilson Engineering 2024); SEPA Checklist dated 6/25; City of Bellingham's site specific Post Point Heron Colony Management Recommendations Update 2019 (Nahkeeta 2020); SEP2000-00065 Phased Determination of Non-significance; SEP2005-00086 Determination of Non-significance; SEP2011-00005 Mitigated Determination of Significance; Final Environmental Impact Statement, City of Bellingham Post Point Wastewater Treatment Plant Upgrade in 1989; SEP2019-0032 Determination of Non-significance; December 2025 Environmental Record Report (attached).

The lead agency has determined that the requirements for environmental analysis, protection, and mitigation measures have been adequately addressed in the development regulations and comprehensive plan adopted under chapter 36.70A RCW, and in other applicable local, state, or

federal laws or rules, as provided by RCW 43.21C.240 and WAC 197-11-158. Our agency will not require any additional mitigation measures under SEPA. This decision was made after review of the environmental information considered on file with the lead agency. This information is available to the public at http://www.cob.org/notices or upon request.

☒ This DNS is issued after using the optional DNS process in WAC 197-11-355. A notice of Application and Optional DNS was issued on **9/11/2025**, there is no further comment period on the DNS.

Appeal Rights: Pursuant to BMC 16.20.210(D), there is no administrative appeal of this environmental determination.

Staff Contact:

Ryan Nelson, Planner
Planning and Community Development Department
210 Lottie Street - Bellingham, WA 98225
Email / Phone: rnelson@cob.org or 360-778-8368

Responsible Official:

Kurt Nabbefeld, Development Services Manager
Planning and Community Development Department
210 Lottie Street, Bellingham, WA 98225



Signature

Section 1

ENVIRONMENTAL RECORD REPORT

The environmental review consisted of analysis of the project proposal based on the following documents included in the environmental record. The purpose and intent of this SEPA Report is to document the SEPA environmental review of the proposal, known as The Post Point Resource Recovery Plant Primary Sludge Tank Replacement Project including review of the applicant's environmental information specified below and consideration of public comments on the proposal to date. Taken together with existing development regulations throughout the Bellingham Municipal Code (BMC), this Report provides the City's basis for issuing a SEPA determination on the proposal.

Documents / References:

- **Exhibit A.**: Post Point Resource Recovery Plant Primary Sludge Tank Replacement Project – Cultural Resources Assessment (ESA 2025);
- **Exhibit B.**: Geotechnical Design Services for the Post Point Primary Sludge Tank Replacement (GeoEngineers 2024);
- **Exhibit C.**: Post Point Primary Sludge Tank Replacement Project Draft Stormwater Engineering Report (Wilson Engineering 2024);
- **Exhibit D.**: SEPA Checklist dated 6/25;
- **Exhibit E.**: City of Bellingham's site specific Post Point Heron Colony Management Recommendations Update 2019 (Nahkeeta 2020) (on file upon request);
- **Exhibit F.**: SEP2005-00086 Determination of Non-significance;
- **Exhibit G.**: Final Environmental Impact Statement dated 1989 (on file upon request);
- **Exhibit H.**: SEP2011-00005 Mitigated Determination of Non-Significance;
- **Exhibit I.**: SEP2019-0032 Determination of Non-significance;
- **Exhibit J.:** 2009 City of Bellingham Comprehensive Sewer Plan (on file upon request)

I. PROPOSAL DESCRIPTION

Construction of a new and similar sized set of tanks and associated infrastructure within the existing wastewater plant boundary to replace the existing tank and restore operational reliability. Proposed project elements include the following: Demolition of the abandoned Chlorine Building 420; Construction of two new 50,000 gallon concrete tanks and a biotrickling filter/odor control system in the approximate location of the Chlorine Building 420; Site restoration/stormwater/yard piping around the new sludge storage tanks and odor control; Repurpose the existing Chlorine Scrubber Building to support the new mechanical and electrical infrastructure associated with the new sludge storage tanks; Structural modifications include adding exterior doors, extending the grade-level floor across the building and roof material replacement; Demolition of the existing sludge storage tank inside Building 510; Replacement of thickened sludge pumps and associated piping inside the Building 530 basement; Demolition of existing waste activated sludge pumps and addition of a new dewatering pump inside the Building 340 basement; Replacement of two existing return activated sludge pumps and piping; Piping modifications between the new sludge storage tanks and the secondary pump station; and Construction of new replacement waste activated sludge pumps.

BACKGROUND

Following a review of the comments received, SEPA checklist (dated 6/25) and Exhibits A-C & E-I, the Bellingham Comprehensive Plan, and the 2009 City of Bellingham Comprehensive Sewer Plan, The Responsible Official has issued a SEPA Determination of Non-Significance. Given the complex nature of the comments received and the complex nature of the operation of the Post Point Wastewater Treatment Plant, Planning staff requested the applicant (Public Works staff) provide a response to the comments received during the public comment period associated with the Post Point Resource Recovery Plant Primary Sludge Tank Replacement Project.

In 1989, the city of Bellingham prepared an Environmental Impact Statement (EIS) (Exhibit G) evaluating alternative processes for secondary treatment at Post Point. These alternatives included solids handling and liquid handling processes. At the conclusion of the EIS process the city chose to implement a sludge and incineration treatment process. The proposal is the continuation and maintenance of portions of those treatment processes. These processes are consistent with the currently adopted City of Bellingham Comprehensive Sewer Plan.

II. PUBLIC COMMENT

Thirty one public comments were received in response to the proposal. Twenty nine comments were received by one party of record as of 11-18-25. A summary of the public comments received and staff responses can be found below in **Attachment 1**. A general theme reflected in public comments received revolved around whether or not the current treatment processes should be continued or whether or not alternative processes should be implemented. The proposal at hand is to replace old equipment and to maintain the existing and chosen treatment processes based on past environmental review. The applicant (city of Bellingham Public Works Department) has indicated that it will begin updating the current 2009 Comprehensive Sewer Plan in 2026. Many of the public comments received may be valuable to the Plan update process as they encourage new and different treatment processes that are not in use now. The update process is likely to take months if not years to finalize and the proposal will ensure the city is able to safely and effectively continue to treat sewer waste. Should new treatment processes be identified and chosen during the comprehensive sewer plan update process, additional environmental review may be necessary to evaluate their potential impacts.

Public comment also received was determined to be not relevant to the exact proposal. SEPA rules require that a threshold determination is made for any proposal or action that is not categorically exempt. WAC 197-11-704 defines “action” as new and *continuing activities*, and “project actions” involve a decision on a *specific project*. WAC 197-11-060 requires agencies to ensure the proposal or action is properly defined. The project as identified in this determination and the submitted materials is very specific and includes replacing certain equipment that supports the “continuing,” adopted, treatment processes. Some comments challenged the adopted treatment process and wanted additional treatment methods to be required. The “specific project” at hand is not consideration of other treatment methods but replacement and maintenance of existing facilities. The upcoming review of the sewer comprehensive plan and its associated environmental review is the appropriate time for those comments.

III. PERMITS/APPROVALS REQUIRED

- Final SEPA Determination
- Shoreline Permit Exemption

- Building & Construction permits
- Northwest Clean Air Agency Approval if determined required

Relationship to other Review Processes: The environmental review process in SEPA is designed to work with other regulations to provide a comprehensive review of a proposal. Most regulations focus on particular aspects of a proposal, while SEPA requires the identification and evaluation of probable impacts to all elements of the environment. Issuance of a SEPA Threshold Determination does not constitute an approval or denial of a proposal. Subsequent review processes retain the ability to approve, approve with conditions or deny an application based on adopted code criteria.

Based on staff's analysis of the environmental record herein and public comments received, the Director or designee under the authority of BMC 16.20.190.A.1-5 may condition a SEPA determination to mitigate direct impacts of a proposal that are deemed necessary to ensure compatibility.

An environmental threshold determination is required by the responsible SEPA Official to ensure that the proposal will not likely have significant adverse environmental impacts and require an EIS. The SEPA Official has determined that the environmental impacts for this Project, as disclosed in this SEPA review, will not have significant adverse environmental impacts.

III. RESPONSIBLE OFFICIAL'S AMENDMENTS TO CHECKLIST

The Applicant's environmental checklist and specific exhibits are incorporated by reference. The public comments and associated responses identified in **Attachment 1** provide additional analysis of specific elements of the environment defined under SEPA where potential impacts were identified by the public. Where warranted, the analysis is intended to also identify potential environmental impacts not addressed by the environmental checklist.

Based on the provisions in RCW 43.21C.240 and the information provided above and attached, the SEPA Official has reviewed the Proposal, the environmental information considered and the environmental record provided herein, has considered the public comment resulting from the Notice of Application and has determined that, with implementation of applicable adopted local, state and federal development regulations, the Proposal is not likely to result in probable significant adverse environmental impacts. Therefore, the SEPA official issues this threshold Determination of Non-Significance (DNS) for the subject proposal.

APPENDIX B.6 EXHIBIT B:
GEOTECHNICAL DESIGN SERVICES REPORT
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

Exhibit B

Geotechnical Design Services

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

for
Carollo Engineers

December 19, 2024

554 West Bakerview Road
Bellingham, Washington 98226
360.647.1510

GeoEngineers

Geotechnical Design Services

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

File No. 0356-185-00
December 19, 2024

Prepared for:

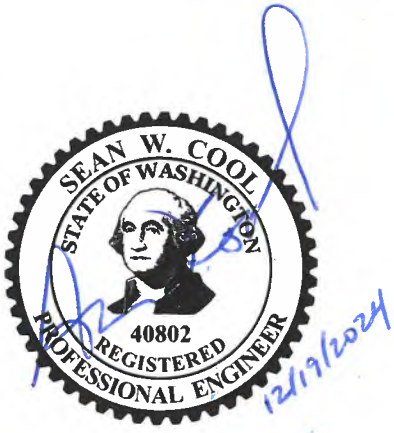
Carollo Engineers
1200 5th Avenue, Suite 900
Seattle, Washington 98101

Attention: Susanna Leung, PE

Prepared by:

GeoEngineers, Inc.
554 West Bakerview Road
Bellingham, Washington 98226
360.647.1510

Aaron Hartvigsen, PE
Associate



Sean W. Cool, PE
Principal

KL:PU:AJH:SWC:seh

Disclaimer: Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

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1.0 Introduction and Scope of Services

This design report presents the results of our geotechnical engineering services for the evaluation of subsurface soil and ground water conditions for the planned Post Point Primary Sludge Tank Replacement project at the Post Point Wastewater Treatment Plant (WWTP) in Bellingham, Washington. The generalized location of the WWTP site is shown in the Vicinity Map, Figure 1.

The purpose of our services was to review existing information and explore subsurface soil and groundwater conditions at the locations of proposed site improvements as a basis to provide geotechnical engineering recommendations for design. Our scope of services included:

- Research and review of available geotechnical information;
- Completing geotechnical explorations including two geotechnical borings;
- Completing laboratory testing on samples obtained from the borings;
- Performing engineering analyses and providing geotechnical conclusions and recommendations for design and construction of the proposed sludge tank replacement; and
- Preparing this geotechnical engineering report.

Our specific scope of services is described in Task Order No. 1 Signed Agreement between Carollo and GeoEngineers, Inc. (GeoEngineers), effective date, July 12, 2023.

2.0 Project Description

We understand that the original design for the WWTP was completed in 1971 with expansions that occurred in 1989 and 2010. Our understanding of this proposed expansion project is based on information provided by Carollo Engineers. The Site and Exploration Plan, Figure 2 attached, shows the proposed locations of the structures identified for these improvements.

As currently envisioned, we understand the City intends to replace the existing steel sludge tank located in the nearby Solids Handling Building 510 with a pair of new 50,000-gallon tanks to be located at the site of the existing Chlorine Building. The weight of the sludge to be held within the tanks is expected to be approximately 440 kips in each tank, for a total of 880 kips. The estimated weight of the concrete structure is 2,100 kips. The existing at-grade Chlorine Building will be demolished, and the new tanks will be exterior (i.e., not housed within a building). The foundations are anticipated to extend approximately 11.5 feet below grade (Elevation 6.8 feet, NAVD 88). Some modified piping within the existing pipe gallery or in new trenches will likely be required for the project, along with other appurtenant site improvements. Adjacent to the new Sludge Tanks will be an Odor Control Facility with a weight of 14 kips, which is planned to be supported by a new slab-on-grade. The existing Scrubber Building 420 has a basement level that extends 9.5 feet below grade and will remain and house additional process improvements but will be structurally modified as necessary per American Society of Civil Engineers (ASCE) 41-17.

3.0 Site Background and Research

The site of the existing Post Point WWTP and proposed Sludge Tank Replacement is an area of historic ground modification, including excavation of peat and organic soils and backfill with structural fill, and some excavation of granular borrow soils in select areas of the site. In addition to local geologic maps, we have reviewed available subsurface information from the previous phases of site development, including the following sources:

- CH2M Hill, "Post Point Wastewater Treatment Plant Upgrade Geotechnical Design Report," September 1971.
- CH2M Hill, "Post Point Wastewater Treatment Plant Upgrade Geotechnical Data Report," September 1989.
- CH2M Hill, "Post Point Wastewater Treatment Plant Upgrade, Initial Design Review Submittal – Design Guidelines," September 1989.
- GeoEngineers, "Post Point Wastewater Treatment Plant Improvements Geotechnical Engineering Report," October 6, 2010.
- GeoEngineers, "Post Point Wastewater Treatment Plant Biosolids Geotechnical Pre-Design Report," February 14, 2022.

4.0 Site Conditions

4.1 SURFACE CONDITIONS

The project site is in the Fairhaven area of south Bellingham, southwest of the intersection of McKenzie Avenue and 4th Street. The site is bounded by Bellingham Bay, an intertidal lagoon, and Burlington Northern Santa Fe (BNSF) railroad tracks and embankment to the west and northwest. An industrial/transportation district is located to the north and northeast. A residential neighborhood is located to the southeast, south, and southwest, primarily on the raised bluffs above the site.

The proposed sludge tank replacement site is located at the southeast corner of two unnamed plant access roads with generally level topography. Steeper slopes are present on the margins of the WWTP toward the south and east. The site is generally covered with asphalt, concrete sidewalks, existing buildings, or manicured lawn. There are numerous underground utilities including utility vaults and tunnels.

4.2 GEOLOGIC SETTING

We reviewed various geologic maps for the project area (Easterbrook 1976, Lapen 2000, and Department of Ecology 1977). The maps indicate that the site is underlain by the Chuckanut Formation bedrock, Fraser drift glacial deposits, alluvium/beach deposits, and artificial fill.

The Chuckanut Formation consists of sandstone, conglomerate, shale, and coal deposits. The bedrock typically encountered in the project vicinity consists of sandstone or siltstone. Bedrock was mapped at/near the ground surface in both the Easterbrook and Lapen maps, although no surface exposures of bedrock are present in the immediate project vicinity, and bedrock was not encountered in the recent site explorations.

The Washington State Department of Ecology (Ecology) Costal Zone Atlas maps soils in the project vicinity as Fraser drift, an undifferentiated glacial deposit composed of various glacial sources including glacial outwash, terrace deposits, glaciomarine drift, and glacial till. The soil types in this unit will depend on the depositional environment.

One predominant soil unit within the Fraser drift is a glaciomarine deposit locally referred to as Bellingham (glaciomarine) Drift. This glaciomarine deposit consists of unsorted, unstratified silt and clay with varying amounts of sand, gravel, cobbles, and occasional boulders. Glaciomarine drift is derived from sediment melted out of floating glacial ice that was deposited on the sea floor. Glaciomarine drift was deposited during the Everson Interstade approximately 11,000 to 12,000 years ago while the land surface was depressed 500 to 600 feet from previous glaciations. This unit is predominantly medium stiff to soft and possesses relatively low shear strength and moderate to high compressibility characteristics in a lowland environment. Glacial till, a subset of the Fraser drift, is typically dense as a result of being overridden by glaciers, with resultant high shear strength and low compressibility characteristics.

Alluvium typically consists of sand, gravel, and silt with areas of clayey and organic soil, deposited on beaches, spits, and modern flood plains, and may include some nearshore inter-tidal deposits. Based on the site location we have interpreted these deposits at the site to be representative of beach deposits.

The artificial fill identified at the site is the result of historical ground modification. The WWTP has been located at the site since 1971. During previous site development, some of the peat has been removed and fill has been brought into the site to raise grades to present elevations. The project area is located within the historical peat removal area.

4.3 GEOLOGICALLY HAZARDOUS AREAS

Geologically hazardous areas are designated by the City of Bellingham Critical Areas Ordinance (CAO) per Bellingham Municipal Code 16.55.410 – 16.55.460. In addition to the definition of the geologically hazardous areas in the CAO, the City has developed a folio of maps that identify these areas in their database. In general, the CAO requires that a qualified professional assess the geologic hazards based on review of available information and field studies, evaluate the specific project proposal with respect to relationship and impact on the hazard area and adjacent sites if appropriate, provide minimum buffers and setbacks, and provide mitigation strategies where appropriate for specific geologic hazards. The geologically hazardous areas include erosion, landslide, seismic, and mines. Additional potential geologic hazards which are not part of the code at this time are sea level rise and tsunami hazards.

4.3.1 Erosion Hazard Areas

Erosion hazard areas are defined by the CAO as areas prone to soil erosion including:

- Any area where soil type is predominantly sand, clay, silt, and/or organic matter and slopes greater than 30 percent.

The site area slopes less than 30 degrees and does not meet the CAO definition for an erosion hazard area. This hazard type can be mitigated with conventional construction practices as discussed later in this report.

4.3.2 Landslide Hazard Areas

Landslide hazard areas are defined by the CAO as those susceptible to landslides and/or subsidence that could include movement of soil, fill materials, rock, or other geologic strata. Specific landslide designations as defined by the CAO include:

- Slopes equal to or greater than 40 percent grade (2.5H:1V [horizontal to vertical] or 22 degrees) with an elevation change of at least 10 feet.

The CAO mapping does not indicate that a landslide hazard is present at the project location. The site does not currently have slopes greater than 40 percent grade with at least 10 feet of vertical relief that will be modified during construction. In our opinion, the site does not meet the definition of a Landslide Hazard Area and this hazard type is not addressed further in this report.

4.3.3 Seismic Hazard Areas

Seismic hazard areas are defined by the CAO as those areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface rupture. Specific areas of very high response to seismic shaking include:

- Areas depicted as “fill” and “alluvial deposits” on geologic maps.
- Areas mapped as high response to seismic shaking.

Some of the soils encountered in our explorations exhibit a moderate to high potential response to seismic shaking. The site is located near the shoreline in an area of modified land overlying a soft soil profile, and therefore is a recognized seismic hazard area. Accordingly, potential impacts and mitigation strategies have been identified and are discussed in the subsequent sections of this report.

4.3.4 Mine Hazard Areas

Mine hazard areas are defined by the CAO as those areas underlain by or affected by historical mine workings. Specific hazard areas include:

- Areas depicted within Geologic Hazards Map , Bellingham, Washington, February 2, 2022.

The project site is located approximately 1,600 feet west of the Union Mine portal location based on the Map Folio. No known mine workings are mapped at the project site. Accordingly, the area does not meet the definition of a mine hazard area and mine hazards will not be addressed further in this report.

4.3.5 Tsunami Hazard and Sea Level Rise

Tsunami hazard and impacts of sea level rise are not specifically defined in the CAO; however, because of the proximity to the shoreline, we evaluated if these potential hazards are present at the site. The site is located in an area that is not a mapped tsunami inundation zone (DNR 2004). Therefore, no mitigation is required.

4.4 SUBSURFACE CONDITIONS

4.4.1 Subsurface Exploration

The subsurface explorations completed by GeoEngineers for this project consisted of two geotechnical borings. Borings B-1-23 and B-2-23 were completed on July 27, 2023, using a hollow stem auger and were advanced to depths of 16½ and 61½ feet below existing ground surface (bgs). The drilled explorations were subcontracted to GeoEngineers. The approximate locations of the explorations are shown in Figure 2. Details of the field exploration program, laboratory testing, and the exploration logs are presented in Appendix A.

4.4.2 Soil Conditions

Subsurface soils encountered were classified as fill, beach deposits, glaciomarine/undifferentiated glacial drift, and glacially consolidated soils. A description of each geologic unit is presented below.

FILL. Fill of variable soil types and density/consistency was encountered in both explorations. The fill thickness ranged from 15 to 16½ feet bgs. Fill consisted of loose to medium dense sand with variable gravel and silt/clay content and is interpreted to have been placed following historical peat removal in this area. Some scattered organic material, shells, and iron-staining were also encountered in the fill soils. Boring B-1-23 terminated in this unit.

BEACH DEPOSITS. Beach deposits were encountered underlying fill in boring B-2-23. This unit was observed from depths of approximately 15 to 20 feet bgs. The beach deposits generally consisted of loose silty sand with shell fragments.

GLACIOMARINE/GLACIAL DRIFT. Glacial deposits interpreted to be a glaciomarine drift unit were encountered underlying beach deposits in boring B-2-23. The glaciomarine drift encountered generally consists of soft to very stiff clay, grading to silty clay with variable sand content. The glaciomarine drift was observed from approximately 20 to 50 feet bgs.

GLACIALLY CONSOLIDATED SOILS. Glacially consolidated soils, distinguished from the glaciomarine drift because of its relatively higher density and lower moisture content, was encountered in boring B-2-23 underlying glaciomarine drift at a depth of approximately 50 feet bgs. The glacially consolidated soil encountered was typically dense to very dense silty sand, medium to coarse sand with silt, and gravel with sand and silt. Exploration B-2-23 terminated in this unit.

4.4.3 Groundwater Conditions

Groundwater was observed at the time of drilling at approximately 25 feet bgs in exploration B-2-23 and was not observed in exploration B-1. We reviewed environmental groundwater monitoring information from Whatcom Environmental for MW-3 that indicates the groundwater elevation is approximately 13 feet. Groundwater levels should be expected to fluctuate in response to rainfall, seasonal variations, possibly tidal variations, and other factors.

5.0 Conclusions and Recommendations

Based on our evaluation, design and construction of the sludge tank is feasible; however, the site conditions include fill, naturally occurring compressible soils, and liquefiable soils at variable depths which must be

carefully considered to achieve desirable foundation performance. A relatively shallow groundwater table is present that affects both design and construction of below-grade structures. The following report sections provide geotechnical considerations for the proposed replacement Sludge Tanks at the location of the existing Chlorine Building that includes pile support to mitigate liquefaction and settlement. Additionally, seismic parameters are provided for the retrofit of the existing Scrubber Building 420.

5.1 GEOLOGIC HAZARDS AND MITIGATION

The following sections discuss recommended mitigation strategies for geologically hazardous areas identified in Section 4.3 above.

5.1.1 Erosion Hazard Considerations

The area of the proposed construction includes a relatively level area of historically placed fill. As currently envisioned, earthwork construction for the sludge tank foundation will require excavations on the order of 9 feet bgs. Although the site does not meet the CAO definition of an erosion hazard area, the primary erosion hazard at the site is from temporary conditions created during construction.

In our opinion, provided typical erosion and sedimentation controls are implemented during construction, the site does not present a significant erosion hazard. Stormwater should be prevented from flowing across disturbed areas and not directed toward the slopes during construction. Temporary erosion control measures should be used during construction depending on the weather, location, soil/rock type, and other factors. Temporary erosion protection (e.g., straw, plastic, or rolled erosion control products [RECPs]) may be necessary to reduce sediment transport until vegetation is established or permanent surfacing applied.

Appropriate best management practices (BMPs) should be incorporated into the temporary erosion and sediment control plan by the civil engineer. All finished slopes should be protected and/or vegetated before the rainy season. Provided that proper grading practices are used and BMPs incorporated into the grading plans, we conclude that the erosion hazard will be adequately mitigated during site development. During construction, the contractor would be subject to Ecology regulations which require performance-based testing of turbidity at all discharge points. Proper construction practices and monitoring procedures will manage the risks to the standard of practice.

5.1.2 Seismic Hazard Considerations and Design

5.1.2.1 SITE SEISMICITY

The site is located within the Puget Sound region, which is seismically active. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca, and North American plates. The Juan de Fuca plate is subducting beneath the North American plate. It is thought that the resulting deformation and breakup of the Juan de Fuca plate might account for the deep focus earthquakes in the region. Hundreds of earthquakes have been recorded in the Puget Sound area. In recent history, four of these earthquakes were large events: (1) in 1946, a moment magnitude (Mw) 7.5 earthquake occurred in the Vancouver Island, British Columbia area; (2) in 1949, a Mw 6.7 earthquake occurred in the Olympia area; (3) in 1965, a Mw 6.6 earthquake occurred between Seattle and Tacoma; and (4) the 2001, Mw 6.8 Nisqually earthquake.

Research has concluded that historical large magnitude subduction-related earthquake activity has occurred along the Washington and Oregon coasts. Evidence suggests several large magnitude

earthquakes (Mw 8 to 9) have occurred in the last 1,500 years, the most recent of which occurred about 300 years ago. No earthquakes of this magnitude have been documented during the recorded history of the Pacific Northwest. Local design practice in Puget Sound and local building codes consider these seismic conditions, including known faults for the design of structures.

5.1.2.2 2021 INTERNATIONAL BUILDING CODE (IBC) SEISMIC DESIGN INFORMATION

We understand that the project components for the tanks will be designed utilizing the 2021 International Building Code (IBC). The 2021 IBC references the 2016 version of Minimum Design Loads for Buildings and Other Structures (ASCE 7-16) for the Site Class determination and the development of seismic design parameters.

Per ASCE 7-16 Section 20.3.1, the site is classified as Site Class F due to the presence of potentially liquefiable soils (discussed below). Site-response analysis is required for Site Class F sites per Section 11.4.8; however, Section 20.3.1 provides an exception for structures that have fundamental periods of vibration less than 0.5 sec, whereby the site class may be determined in accordance with Section 20.3 (i.e., the underlying site class not considering liquefaction) and the corresponding site coefficients determined based on mapped seismic parameters in Section 11.4.4. We anticipate that the proposed structure has a fundamental period of vibration that is less than 0.5 sec; therefore, the exception in Section 20.3.1 applies. This assumption should be confirmed by the structural engineer.

Based on the subsurface data from our borings, the weighted average of the blow counts in the top 100 feet was estimated, which is used as a parameter to estimate the seismic site class of the site, as per ASCE 7-16. The underlying site is best classified as Site Class D – Stiff Soil Profile. Per ASCE 7-16 Section 11.4.8 a ground motion hazard analysis is required for structures on Site Class D with S_1 greater than or equal to 0.2 g (where g represents gravitational acceleration). The mapped S_1 value for this site is 0.358 g. Exception 2 in Section 11.4.8 allows the structural designer to use ground motions based on the site class and mapped spectral acceleration rather than completing a site-specific response analysis. Where the value of 'T' in this exception represents the fundamental period of the structure, T_S=0.62 sec, and T_L=16 sec.

The design parameters for the 2021 IBC are summarized in Table 1. These values are based on an earthquake event that has a 2 percent chance of exceedance in a 50-year period (2,475-year return period).

If requested, we can complete a site-specific seismic response analysis or a ground motion hazard analysis. These analyses could provide reduced seismic demands relative to the parameters in Table 1 and the requirements of ASCE 7-16 Section 11.4.8 Exception 2 depending on the structure configuration and site-specific subsurface conditions.

TABLE 1. MAPPED 2021 IBC SEISMIC DESIGN PARAMETERS

SEISMIC DESIGN PARAMETERS	RECOMMENDED VALUE[1,2]
Site Class	D[3, 4]
Mapped Spectral Response Acceleration at Short Period (S_S)	1.018 g
Mapped Spectral Response Acceleration at 1 Second Period (S_1)	0.358 g
Site Modified Peak Ground Acceleration (PGA_M)	0.507 g

Site Amplification Factor at 0.2 second period (F_a)	1.093
Site Amplification Factor at 1.0 second period (F_v)	1.942
Design Spectral Acceleration at 0.2 second period (S_{DS})	0.742 g
Design Spectral Acceleration at 1.0 second period (S_{D1})	0.463 g
S_{D1}/S_{DS} (T_S)	0.62 seconds

Notes:

[1] Parameters developed based on Latitude 48.718156° and Longitude -122.51382° using the online ASCE 7 Hazard Tool.

[2] These values are only valid if the structural engineer utilizes Exception 2 of Section 11.4.8 (ASCE 7-16).

[3] The site may be classified as Site Class D if the exception applies in Section 20.3.1 (ASCE 7-16).

[4] Soil Profile Type D Description: Stiff Soil Profile (15 ≤ N ≤ 50).

5.1.2.3 2017 ASCE 41-17 SEISMIC DESIGN INFORMATION

Seismic design of the proposed improvements for the Scrubber Building will be completed using procedures outlined in ASCE 41-17 (2017). We understand the existing structures will be evaluated based on both the Basic Safety Earthquake-1 Event (BSE-1E) and Basic Safety Earthquake-2 Event (BSE-2E). The desired performance objectives are taken as a seismic hazard with a 20 percent probability of exceedance in 50 years (225-year return period) and with a 5 percent probability of exceedance in 50 years (975-year return period), for the two events respectively. The site is classified as Site Class F per ASCE 7-16 (2016) Chapter 20 due to the presence of potentially liquefiable soils at the site (discussed later). In the absence of the potential for liquefaction triggering, the site would otherwise be classified as Site Class D based on blow count data collected during site exploration.

ASCE 41-17 does not provide seismic parameters for Site Class F sites and requires site-specific ground motion procedure to determine if the short-period spectral response acceleration (S_S) value is greater than or equal to 0.2 g. We understand that the building period meets the ASCE 41-17 exception for structures below periods of 0.5 seconds, in which case the parameters provided for Site Class D below are appropriate.

Recommended seismic design parameters for code level seismic design in accordance with ASCE 41-17 (and ASCE 7-16) are presented in Table 2 below and consider Risk Category III and Site Class D.

TABLE 2. ASCE 41-17 SEISMIC PARAMETERS

ASCE 41-17 PARAMETER	BSE-1E RECOMMENDED VALUE[1]	BSE-2E RECOMMENDED VALUE[1]
Site Class	D[2]	D[2]
Short-period Spectral Response Acceleration, S_S	0.36 g	0.76 g
1-second Period Spectral Response Acceleration, S_1	0.115 g	0.265 g
Short-period Site Coefficient, F_a	1.512	1.196
Long-period Site Coefficient, F_V	2.37	2.07
Site Class Adjusted Short-period Spectral Response Acceleration, S_{XS}	0.544 g	0.909 g
Site Class Adjusted 1-second Spectral Response Acceleration, S_{X1}	0.272 g	0.549 g

Notes:

[1] Parameters developed based on Latitude 48.718156° and Longitude -122.51382° online ASCE 7 Hazard Tool.

[2] Parameters are provided for Site Class D.

5.1.2.4 LIQUEFACTION POTENTIAL

Liquefaction is a phenomenon where soils experience a rapid loss of internal strength as a consequence of strong ground shaking. Loss of bearing support, ground settlement, lateral spreading, and/or sand boils may result from liquefaction. Conditions favorable to liquefaction occur in very loose to medium dense, clean to moderately silty sand that is below the groundwater level. Dense soils or soils that exhibit cohesion are less likely to be susceptible to liquefaction. Soils considered susceptible to liquefaction underlying the project site include a limited thickness of granular beach deposits.

The evaluation of liquefaction potential is complex and is dependent on numerous site parameters, including soil grain size, soil density, site geometry, static stresses, and the magnitude and ground acceleration of the design-level earthquake. Typically, the liquefaction potential of a site is evaluated by comparing the cyclic shear stress ratio (the ratio of the cyclic shear stress to the initial effective overburden stress) induced by an earthquake to the cyclic shear stress ratio required to cause liquefaction.

We evaluated the liquefaction potential of the saturated soils underlying the site following the methods of Youd and Idriss (2001) and estimated settlement based on two methods (Tokimatsu and Seed 1987; Ishihara and Yoshimine 1992) based on the Standard Penetration Test (SPT) data from our drilled borings. For this site, the design-level earthquake consists of a moment magnitude of 6.97 and a peak horizontal ground acceleration of 0.507 g. The design earthquake parameters were developed using published hazard maps associated with an earthquake event that has a 2 percent chance of exceedance in a 50-year period (2,475-year event) as required by IBC.

Groundwater was assumed to be encountered at a depth of about 5 feet bgs. The results of our analyses indicate that saturated portions of the loose to medium dense native beach deposits have a moderate potential for liquefaction during a design earthquake event. Our analyses indicate that settlement caused by liquefaction of the saturated portions during a design earthquake could be on the order of 1½ to 3 inches. The variability of site conditions suggests that liquefaction and subsequent settlement will be sporadic across the site and differential settlement over short distances could equal the total anticipated liquefaction settlement. Pile foundations discussed subsequently in this report may effectively mitigate liquefaction induced settlement.

5.1.2.5 LATERAL SPREADING

In addition to settlement, there is the possibility that lateral spreading of the soils could occur as a result of soil liquefaction. Lateral spreading involves lateral displacement of large, surficial blocks of non-liquefied soil, as well as the liquefied soil itself, as the underlying soil layer liquefies. Lateral spreading generally develops in areas where sloping ground is present or near a free face, such as a river or slough. If liquefaction were to occur within the granular layers at the site, we anticipate that, because of the sporadic nature of the liquefiable soils, there would be a relatively low potential for lateral spreading to occur at the site. During a design earthquake, lateral spreading displacements, characterized by movement of the soils towards Bellingham Bay, are estimated to be on the order of 1 to 2 inches for a 2,475 year earthquake, with perhaps little to no lateral spreading occurring for lower levels of ground shaking. The lateral displacement is likely further mitigated by other structures between the proposed Sludge Tank and Bellingham Bay.

5.1.2.6 SURFACE FAULT RUPTURE

The nearest active faults include the Birch Bay fault, located approximately 7 miles northwest of the site, and the Sandy Point fault, located approximately 8 miles north of the site. These faults are not capable of producing a Mw 7.0 seismic event based on the United States Geologic Survey (USGS) deaggregation tool. Per ASCE 7-16 Section 11.4.1, the site is not considered a near-fault site, and therefore, the risk of surface rupture at the site is interpreted to be low.

5.2 EXISTING SCRUBBER BUILDING CONSIDERATIONS

The existing Scrubber Building will be modified and repurposed as the Sludge Storage Building. The existing building has a basement constructed with a mat foundation and concrete walls. The bottom of the foundation is approximately 11 feet below the ground level. The existing building is bearing on soil layers consisting of loose to medium-dense native beach deposits and granular portions of the glacial drift, which has a moderate potential for liquefaction during a design earthquake event. Liquefaction could result in vertical settlement of 1½ to 3 inches and differential settlement of 1 to 2 inches over the width of the structure, which are considered to be within acceptable limit for mat-type foundation. The basement can be considered a rigid foundation for the building and perform during a liquefaction event under design earthquake level. New utility lines (such as pipes, ducts, conduits, ductbanks, etc.) to the structure should be provided with flexible joints to accommodate the potential liquefaction settlement

5.3 SETTLEMENT CONSIDERATIONS

The combined short and long-term settlement estimates for this project are 2¾ inches which exceed the tolerable total vertical displacement of 1 inch if the foundation loads for the new replacement Sludge Tank were supported by the liquefiable beach deposits and soft to stiff clay that is located below the proposed foundation elevation. As settlement mitigation, we recommend that the Sludge Tanks be supported by piles as discussed below. Various ground improvement and pile support options were considered. However, based on the nearby utility tunnel and other nearby existing infrastructure, including the basement in the adjacent Scrubber Building 420, methods that include intense vibration such as driven piles or vibroreplacement aggregate piers were not considered feasible. Recommendations for drilled augercast piles are provided in the following sections.

5.4 PILE FOUNDATION RECOMMENDATIONS

Pile foundations are an option to provide foundation support and reduce anticipated total and differential settlements within tolerable levels and avoid liquefaction induced subsidence to the structures. As currently envisioned, augercast piles are the preferred pile type to support the proposed Sludge Tanks because of the relatively deep soft soil profile under the proposed structure and heavy loads applied that are not compensated with foundation excavation.

5.4.1 Augercast Piles

Augercast piles are the preferred pile type because they are a relatively economical type of deep foundation, there is minimal disturbance of adjacent structures during installation, the equipment provides a cased hole for installation of the pile, and because there is a lower level of construction noise (i.e. no pile driving) with lesser impacts to adjacent wildlife habitat. Drilled shafts would require temporary casings because of the soft soils. Other pile types, such as driven steel pipe or H-piles, are also feasible, but with greater noise impacts. Recommended capacities for these pile types can be provided if requested.

Augercast piles are constructed using a continuous flight hollow stem auger attached to a set of leads supported by a crane. The first step in the pile casting process consists of drilling the auger into the ground to the specified tip elevation of the pile. Grout is then pumped through the hollow stem auger upon steady withdrawal of the auger and replaces the soils removed on the flights of the auger. The final step is to install a steel reinforcing cage and typically a center bar into the column of fresh grout. The benefit of using augercast piles in this environment is that the auger provides support for the soils during the pile installation process, thus eliminating the need for temporary casing or drilling fluid. Augercast piles were successfully used for support of the new Secondary Clarifier and Activated Sludge Basin in 2012.

5.4.2 Vertical Axial Capacities

We have estimated the vertical axial load capacities of 18-inch and 24-inch diameter augercast piles. Axial pile capacity in compression will be developed from a combination of frictional resistance in the medium stiff to stiff clayey glacial drift soils underlying the site, and end bearing in the dense glacially consolidated soils. The surface of the glacially consolidated soil should be anticipated to vary and will derive most of their support from end bearing in this unit. Uplift pile capacity at both locations will be developed from frictional resistance in the glacial drift and glacially consolidated soils.

Allowable pile capacities are provided for Allowable Stress Design (ASD). The allowable capacities are for combined dead plus long term live loads and may be increased by one-third when considering design loads of short duration such as seismic forces. The allowable capacities are based on the strength of the supporting soils for the depths below the existing ground surface and include a factor of safety of about 3 for end bearing and 2 for shaft friction. The capacities apply to single piles. If piles are spaced at least three pile diameters on center as recommended, no reduction for group action is needed. The values provided below include a reduction in axial capacity resulting from downdrag of existing fill soils overlying the liquefiable beach deposits.

The structural characteristics of pile materials and structural connections may impose limitations on pile capacities and should be evaluated by the structural engineer. For example, steel reinforcing will be needed for augercast piles subjected to uplift or large bending moments.

Table 3 below presents a summary of the allowable axial pile capacity (compression and uplift) for the proposed pile locations. To achieve suitable bearing at these locations, we recommend a minimum embedment of about 5 feet into the dense glacial till and an estimated pile tip at Elevation -35 feet. Based on our subsurface explorations, pile lengths on the order of 43 to 53 feet bgs are anticipated to achieve the desired embedment. We anticipate that the glacially consolidated soil layer will be encountered at shallower depths toward the eastern end of the proposed building footprint.

TABLE 3. AXIAL PILE CAPACITIES –SLUDGE TANKS

EMBEDMENT DEPTH IN GLACIAL TILL (FEET)	ALLOWABLE PILE CAPACITY (KIPS)			
	18-INCH AUGERCAST PILE		24-INCH AUGERCAST PILE	
	COMPRESSION	UPLIFT	COMPRESSION	UPLIFT
5	170	60	270	80

5.4.3 Lateral Capacities

Lateral loads can be resisted by the skin friction and passive soil pressure on the vertical piles and by the passive soil pressures on pile caps. Passive pressure on buried retaining walls for lateral resistance may also be used if walls are designed for pressures provided in Section 5.6.2. Side friction on buried retaining walls for lateral resistance may be included based on recommendations provided in Section 5.6.3. Because of the potential separation between the pile-supported foundation components and the underlying soil from settlement, base friction on pile caps should not be included in calculations for lateral capacity.

We analyzed the ultimate lateral load capacity of 18-inch and 24-inch augercast piles with the pile head fixed against rotation. The soil profile for lateral pile evaluation was completed for two cases. For the Sludge Tanks the top of pile was assumed to be at a depth of at least 11.5 feet bgs and for the Odor Control Slab the top of pile was assumed at a depth of at least 1.5 feet bgs with soil profile based on boring B-2-23. We evaluated the lateral capacity for ¼-inch, ½-inch, and 1-inch deflection at the top of the pile for the Sludge Tanks and ¼-inch, ½-inch, and 1-inch deflection at the top of the pile for the Odor Control Slab. The results of our analyses are summarized in Table 4 for the Sludge Tanks and Table 5 for the Odor Control Slab. The results represent ultimate values and do not include a factor of safety. Plots of the lateral pile analysis, including deflection, shear, and moment profiles, are presented at the end of this report in Figures 3 through 6. The figures start with top of pile equal to depth of 0 feet.

TABLE 4. ULTIMATE LATERAL PILE CAPACITY – AUGERCAST PILES AT SLUDGE TANKS

PILE DIAMETER	LATERAL DEFLECTION (INCH)	FIXED HEAD CONDITION (AT BASIN)	
		LATERAL LOAD (KIPS)	MAXIMUM BENDING MOMENT (INCH-KIPS)
18-inch	¼	11	370
	½	17	640
	1	22	870
24-inch	¼	21	810
	½	31	1,360
	1	41	1,870

TABLE 5. ULTIMATE LATERAL PILE CAPACITY – AUGERCAST PILES AT ODOR CONTROL SLAB

PILE DIAMETER	LATERAL DEFLECTION (INCH)	FIXED HEAD CONDITION (AT SLAB)	
		LATERAL LOAD (KIPS)	MAXIMUM BENDING MOMENT (INCH-KIPS)
18-inch	¼	16	250
	½	25	510
	¾	32	720
	1	38	910
24-inch	¼	24	610
	½	42	1,020
	¾	59	1,420
	1	73	1,600

5.4.4 Settlement

We estimate that the post-construction settlement of pile foundations, designed and installed as recommended, will be on the order of ¾-inch or less. Maximum differential settlement should be less than about one-half the post-construction settlement. Most of this settlement will occur rapidly as loads are applied. Pile foundations will effectively mitigate the liquefaction induced settlement discussed in the Seismic Hazard Considerations section of this report and long-term consolidation settlement potential.

5.4.5 Construction Considerations

The augercast piles should be installed to the recommended depth or tip embedment using a continuous flight, hollow-stem auger. We recommend that the augercast piles be installed by a contractor experienced in their placement and using suitable equipment. Excavation to the subgrade will likely reach loose/soft soil that will easily become disturbed and may not adequately support construction equipment without mitigation. Subgrade performance will be improved with appropriate dewatering. Additionally, a gravel working mat about 24 inches thick or other measures to distribute equipment loads may be required to support equipment during pile installation.

5.4.5.1 DRILLING AND GROUTING

The augercast piles generate cuttings as the soil is removed. As is standard practice, the pile grout must be pumped under pressure through the hollow stem as the auger is withdrawn. Maintenance of adequate grout pressure at the auger tip is critical to reduce the potential for encroachment of adjacent native soils into the grout column. Grout pumps must be fitted with a volume-measuring device and pressure gauge so that the volume of grout placed in each pile and the pressure head maintained during pumping can be observed. A minimum grout line pressure of 100 pounds per square inch (psi) should be maintained.

The action of the auger may tend to disturb the soil at the bottom of the drilled hole, which would result in decreased end-bearing capacity. In order to minimize the negative effects of this disturbance, we recommend that the pile contractor be required to rotate the auger following pumping of the first few cubic feet of grout and prior to auger withdrawal. This will mix any loose cuttings at the bottom of the hole with the grout, thus developing the required end-bearing capacity.

The glacial drift soil can have occasional cobbles and boulders and even clusters. It may be necessary to relocate some piles if refusal is encountered prior to achieving recommended embedment in the dense glacial layer.

5.4.5.2 AUGER WITHDRAWAL

The rate of withdrawal of the auger must remain constant throughout the installation of the piles in order to reduce the potential for necking of the piles. The rate of auger withdrawal should be controlled during grouting such that the volume of grout pumped is equal to at least 115 percent of the theoretical pile volume. A minimum head of 10 feet of grout should be maintained above the auger tip during withdrawal of the auger to maintain a full column of grout and prevent hole collapse. Failure to maintain a constant rate of withdrawal of the auger will result in immediate rejection of that pile. Reinforcing steel for bending and uplift should be placed in the fresh grout column as soon as possible after withdrawal of the auger. Centering devices should be used to provide concrete cover around the reinforcing steel.

5.4.5.3 CONSTRUCTION SEQUENCING

We recommend that there be a waiting period of at least 12 hours between the installation of piles spaced closer than 8 feet, center-to-center. This waiting period is necessary to avoid disturbing the curing concrete in previously cast piles.

5.4.5.4 VERIFICATION AND TESTING

It should be noted that no direct information regarding the capacity of augercast piles (e.g., driving resistance data) can be obtained while this type of pile is being installed. Therefore, we recommend that pile installation operations be monitored by the Geotechnical Engineer or his representative. The Geotechnical Engineer will observe the drilling operations, monitor grout injection procedures, record the volume of grout placed in each pile relative to the calculated volume of the hole, and evaluate the adequacy of individual pile installations. We also strongly recommend that a pre-construction meeting take place with the pile contractor, the owner, and the Geotechnical Engineer to discuss pile construction techniques.

Federal Highway Administration (FHWA) Geotechnical Engineering Circular No. 8 – Design and Construction of Continuous Flight Auger Piles outlines guidelines for pre-production, verification load testing, and integrity testing. Testing could include pre-production static load testing, rapid dynamic test (RDT) or dynamic load test (DLT) for verification, and sonic echo testing for integrity. In our experience, this type of testing is uncommon except for large projects or projects of a critical nature. At a minimum, we recommend the geotechnical observations described above along with appropriate materials testing to verify quality of grout and steel materials.

5.5 PILE SUPPORTED MAT FOUNDATION RECOMMENDATIONS

We understand that the proposed Sludge Tank foundations will be supported on a pile supported mat foundation.

We anticipate that the mat foundation will be supported on a working platform consisting of 12 to 24 inches of crushed rock.

We recommend that all footing excavations be observed by a representative of our firm immediately prior to construction of a working pad and any reinforcing steel and structural concrete placement for footings, to confirm that the bearing surface has been prepared in a manner consistent with our recommendations and that the subsurface conditions are as expected.

Exterior footings should be founded at least 18 inches below the lowest adjacent finished grade. Interior footings should be founded a minimum of 12 inches below lowest adjacent soil grade.

5.6 ADDITIONAL DESIGN FOR BELOW-GRADE STRUCTURES

5.6.1 Lateral Earth Pressures

Lateral soil pressures acting on the retaining walls will depend on the nature and density of soil behind the wall, the amount of lateral wall movement which occurs as backfill is placed, and the inclination of the backfill surface. For walls free to yield at the top at least one thousandth of the wall height (i.e., wall height times 0.001), soil pressures will be less than if wall movement is restrained. We recommend that walls free to yield at the top and supporting horizontal backfill be designed using an equivalent fluid density of 35 pounds per cubic foot (pcf). We recommend that walls that extend below groundwater levels be

designed using an equivalent fluid density of 80 pcf to account for combined soil plus hydrostatic pressures unless drainage provisions are included. If the walls will be restrained against movement, we recommend using an equivalent fluid density of 55 pcf above the water table and 90 pcf below the water table.

We also recommend a uniformly distributed seismic surcharge of 9H pounds per square foot (psf) (H = Height of wall) be applied to the wall with a corresponding reduction in the factors of safety to 1.1 or greater. Lateral pressure resulting from seismic surcharge loading is additive to lateral soil pressures computed as recommended above.

Surcharge loading should be added to all below-grade walls where appropriate. If traffic can be within about 10 feet of the top of the wall, we recommend that the walls be designed for a uniform horizontal surcharge load on the order of 70 psf, which represents a 250 vertical traffic surcharge. For design purposes, this is equivalent to assuming approximately 2 additional feet of soil above site grades using the equivalent fluid densities described above. Temporary surcharge loading during construction resulting from equipment and soil stockpiles should be evaluated by the contractor.

In order to prevent overstressing the concrete retaining walls and causing bulging or rotation, we recommend that structural fill placed against the back of the wall be compacted with lighter weight hand-operated equipment and within the range of 90 to 92 percent of the maximum dry density (MDD). Backfill should be placed after the concrete has had sufficient time to cure and develop the necessary strength.

5.6.2 Base Friction and Passive Resistance

Lateral foundation loads may be resisted by passive soil pressures on the sides of the buried foundation element and by friction on the bases of the foundation. For foundation elements supported in accordance with our recommendations on 18-inches minimum of crushed surfacing base course (CSBC), the allowable frictional resistance may be computed using a coefficient of sliding of 0.45 applied to vertical dead-load forces.

The passive resistance of backfilled soils may be computed using an equivalent fluid pressure of 300 pcf or 150 pcf if below groundwater, where the foundation element is surrounded by on-site soil or structural fill compacted as described in the “Fill Placement and Compaction” section of this report. The passive earth pressure value assumes that the adjacent grade is level and the compacted structural fill extends a minimum distance of 1.5 times the footing depth beyond the edge of the foundation. The top foot of fill material should generally be neglected when calculating passive lateral earth pressures. A factor of safety of about 1.5 has been applied to the above values.

5.6.3 Buoyancy and Uplift

We recommend that the structures that extend below the groundwater table be designed to resist hydrostatic uplift. Without drainage provisions, the excavation backfill could have the potential to collect water in the lower permeability native soil and create a “bathtub” effect. The structures could alternatively be designed for hydrostatic uplift based on a representative groundwater level or planned relief drain elevation.

Resistance to uplift and lateral loads can be developed by the dead weight of the structure and friction along the sides of the structure. Frictional resistance can be computed using a coefficient of friction of 0.35

applied to the lateral soil pressures. This coefficient of friction is an allowable value and includes a factor of safety of approximately 1.5. We recommend that lateral soil pressures for uplift and lateral resistance be computed using an equivalent fluid density of 35 pcf above the groundwater table and 18 pcf below the groundwater table. In addition to the above means of resisting uplift, the structure may be constructed with a base that extends beyond the structure walls so that the weight of overlying soil resists a portion of the uplift. For this purpose, the overlying backfill may be assumed to have a submerged unit weight of 60 pcf.

5.6.4 Buried Slabs

Buried slabs, such as for the tops of utility vaults or tunnel roofs, should be designed for a uniform pressure of 130 psf per foot of fill placed above the slab. Other loading, such as traffic surcharge, should also be applied to these slabs.

5.7 PIPE DESIGN CONSIDERATIONS

Various piping and utility corridors will be required to connect the new facilities to the existing infrastructure. We should review material types and depths during final design.

Zones of perched groundwater seepage should be anticipated. The groundwater table will likely be encountered at depths of 5 feet throughout the site. The contractor should anticipate, at a minimum, all utility excavations will require a trenchbox for sidewall support and sumps and pumps to control groundwater seepage. At locations where nearby infrastructure must be protected, shoring that limits lateral movement of soil combined with more aggressive dewatering, as described in this report, may be necessary.

5.7.1 Utility Connection to existing Scrubber Building

There will be new utility connections to the existing Scrubber Building (to be the Sludge Storage Building). The estimated liquefaction settlement is expected to be 1½ to 3 inches. The proposed Sludge Tanks will be pile supported with anticipated foundation settlement of 1-inch or less. Therefore, any utility connections should include adequate flexibility in design to accommodate expected differential settlement.

5.8 CORROSION POTENTIAL

Corrosion potential of selected soil samples was conducted based on laboratory chemical testing subcontracted to Norton Corrosion of Woodinville, Washington. Laboratory testing included pH, chloride, sulfate, sulfide, redox potential, and resistivity, the results of which are summarized in Table 6 below, with the full laboratory results presented in Appendix B. The results of the chemical testing were compared to critical values presented in FHWA-RD-89-186 (FHWA 1990) for evaluating aggressiveness of soil environment for steel reinforcement.

TABLE 6. RESULTS OF LABORATORY TESTING FOR CORROSION POTENTIAL

BORING NO.	SAMPLE NO. (DEPTH)	PH	SULFIDE (PPM)	REDOX POTENTIAL (MV)	RESISTIVITY (OHM/CM) NATIVE	RESISTIVITY (OHM/CM) SATURATED	CHLORIDE (PPM)	SULFATE (MG/L)
B-1	S-2 (2.5 feet)	5.9	ND*	104.2	8,700	3,800	93	32
B-1	S-4 (7.5 feet)	7.0	ND*	151.2	43,000	7,100	<30	33
B-2	S-2 (2.5 feet)	6.6	ND*	140.5	73,000	15,000	<30	IS
B-2	S-4 (7.5 feet)	6.9	ND*	173.2	9,800	5,000	<30	<2

Notes:

mg/L = milligrams per liter; mV = millivolts; ohm/cm = ohms/centimeter; ppm = parts per million; ND = not detected; IS = insufficient sample

Based on the referenced document, soils with a redox potential between100 and 200 millivolts (mV) are considered to be moderately corrosive. Soils with a resistivity between 2,000 and 5,000 ohms per centimeter (ohm/cm) are considered to be moderately corrosive; soils with a resistivity between 5,000 and 10,000 ohm/cm are considered mildly corrosive; and soils with a resistivity greater than 10,000 ohm/cm are considered to be non-corrosive. The same FHWA document presents the following recommended electrochemical limits for fill soils:

pH	greater than 4.5 and less than 9.5
chlorides	less than 100 parts per million (ppm)
sulfates	less than 200 ppm
resistivity	greater than 5,000 ohm/cm

Based on these limits, all the samples tested have at least some corrosion potential to steel reinforcement.

5.9 EARTHWORK

5.9.1 General

Excavation for the proposed sludge tank foundations are anticipated to extend to depths of approximately 13 feet bgs. Temporary shoring and dewatering is anticipated to be limited. The site soils that will be excavated generally consist of various fill soils. These are moisture-sensitive soils and are susceptible to disturbance by construction equipment during wet weather. We expect that stormwater would be contained in the excavations.

Temporary erosion control measures should be used during construction depending on the water, location, soil type, and other factors. Temporary erosion protection (RECPs) may be necessary to reduce sediment transport until vegetation is established or permanent surfacing applied. Appropriate BMPs should be incorporated into the temporary erosion and sediment control plan developed by the civil engineer. We are available to provide input if requested.

5.9.2 Site Preparation

The proposed improvements will be constructed in areas currently surfaced with an existing building, manicured grass, and pavement. We recommend that any existing vegetation and topsoil or other surfacing be stripped from all new building and pavement areas. All existing foundation elements and utilities should also be removed and backfilled with structural fill per section below. For planning purposes, we recommend stripping depth in vegetated areas in the range of 3 to 6 inches, and in currently developed areas in the range of 6 to 12 inches. Roots should be grubbed to a diameter less than 1 inch. The stripped material should be wasted off-site. We recommend that the existing pavement be removed from the existing driveway or sidewalk areas where necessary and a uniform subgrade be prepared in all areas for support of the new pavement section.

The prevailing site soils are moisture-sensitive and will be difficult to operate on and very difficult to compact during wet weather. Rubber-tired vehicles can easily disturb this type of soil.

We recommend that the subgrade be evaluated by a representative of GeoEngineers to confirm the subgrade is adequate for structural support. We recommend that the subgrade for structural areas be thoroughly compacted with heavily loaded rubber-tired construction equipment if site preparation is done during extended dry weather conditions. The compaction should be observed by one of our geotechnical engineers, who will evaluate the subgrade. Where proofrolling is not feasible, we recommend the subgrade be evaluated by probing. In areas where adequate compaction cannot be achieved, additional overexcavation of soft, organic, or deleterious materials may be required as directed by the field engineer.

5.9.3 Base Preparation

The base of excavations for below grade structures will vary based on historic grading, site geology, and groundwater level. The subgrade soils for the sludge tank foundations could be somewhat variable and will most likely consist of existing fill placed following previous peat removal activities. We therefore recommend that a minimum 12-inch layer of clean sand and gravel (Select Import Fill as described in this report) be placed over the subgrade; however a thicker layer, up to 24 inches, or other means of distributing equipment loads, may be required to support construction equipment during wet weather.

5.9.4 Temporary Excavations

All excavation activities must be completed in accordance with applicable county, state, and federal safety standards. The on-site soils can generally be excavated using conventional earthmoving equipment, although some large cobbles should be expected. Regardless of the soil type encountered in the excavation shoring, trench boxes or sloped sidewalls will be required for excavations deeper than 4 feet under Washington State Administrative Code (WAC) 296-155, Part N. The stability of open-cut slopes is a function of soil type, groundwater level, slope inclination, and nearby surface loads. The use of inadequately designed open cuts could impact the stability of adjacent structures and existing utilities and endanger personnel. We expect that much of the trench excavations will be made as open cuts in conjunction with the use of sloped sidewalls and/or a trench box for shielding workers.

In our opinion, the contractor will be in the best position to observe subsurface conditions continuously throughout the construction process and to respond to variable soil and groundwater conditions. Therefore, we recommend that the contractor have the primary responsibility for deciding whether to use an open-cut

slope rather than some form of temporary excavation support and/or dewatering strategies. Temporary excavation considerations for the various project elements are discussed below:

Soil and groundwater conditions within the areas of previous peat removal could be extremely variable. If significant quantities of clean granular fill were used as backfill, groundwater flow into excavations could be rapid. Groundwater seepage may also occur where layers/lenses of granular material occur within finer grained fill.

We suggest that the contractor "pothole" the areas of excavation and alignment of any utility trenches in advance of opening the excavation to put an excavation strategy/dewatering plan together as appropriate. Dewatering considerations are provided in a subsequent section of this report.

5.9.4.1 TEMPORARY CUT SLOPES

The state regulations allow temporary slopes for excavations less than 20 feet deep, from 0.75H:1V to 1.5H:1V depending upon soil type. The regulations assume that surface loads such as construction equipment and storage loads will be kept a sufficient distance away from the top of the cut so that the stability of the excavation is not affected. Based on our explorations, the site soils are as follows:

- The existing fill and loose to medium dense granular beach deposit soils are considered to be a "Type C" soil by the regulations, which has an allowable temporary maximum slope angle of 1.5H:1V.

The regulations and maximum slope angles presented assume that groundwater seepage is not present in these soils. Therefore, the soils must be above the groundwater level and/or in a dewatered condition.

If temporary cut slopes experience excessive sloughing or raveling during construction, it may become necessary to modify the cut slopes to maintain safe working conditions and protect adjacent facilities or structures. Slopes experiencing excessive sloughing or raveling can be flattened, regraded to add intermediate slope benches, or additional dewatering can be provided if the poor slope performance is related to groundwater seepage. Berms, hay bales or other provisions should be installed along the top of excavations to intercept surface runoff to reduce the potential for sloughing and erosion of cut slopes during wet weather.

5.9.4.2 TEMPORARY SHORING – TRENCH BOXES

We recommend that a shoring system be used where excavations are located adjacent to existing utilities, roadways, or structures where soil movement or ground loss could result in damage to these facilities. Generally, a trench box is not considered appropriate in areas where soil movement adjacent to the trench is unacceptable. Typically, a trench box is used to protect workers from injury should the sidewall collapse. If a sidewall collapses, a contractor typically will backfill the void space in the trench box to the extent practical. Upon completion of the work the contractor will then pull the trench box out and the sidewalls cave and surface distress or disruption occurs.

A trench box can be used where sidewall support is required provided that it is (1) designed for anticipated earth pressures and hydrostatic pressures if appropriate and (2) the installation, moving and backfilling can be accomplished in such a manner that significant yielding does not occur. Braced or unbraced shoring (several types of adjustable braced trench shoring systems are available) of various types could be used where protection of existing infrastructure is necessary.

If a trench box is used and the soils are dewatered below the base of the excavation (prior to excavation), yielding/movement of the sidewalls is likely to occur within a 1.5H:1V slope as measured from the bottom of the excavation. If the soils are not dewatered to at least 1 foot below the bottom of the trench prior to and during excavation, the area of disturbance could be greater than a 1.5H:1V slope as measured from the bottom of the excavation. The following should be implemented for the trench box shoring systems for the project:

- At locations where settlement could be detrimental to adjacent structures, utilities, or pavements, the shoring system should be designed to prevent significant lateral movement of the existing soils.
- Precautions should be taken during removal of the shoring or sheeting materials to minimize disturbance of the pipe, underlying bedding materials, and natural soils.
- Trench boxes should be of sufficient size, both vertically and horizontally, to support the excavation without excessive deformation of the natural soils.
- The open excavations should be backfilled as soon as practical after the shoring has been removed.
- Heavy construction equipment, construction materials, and excavated soil should not be allowed within a distance, measured from the edge of the excavation, equal to half the depth of the excavation, unless the shoring system has been designed for the additional lateral pressure.

Because of the diversity of available shoring systems and construction techniques, the design of temporary shoring is most appropriately left up to the contractor proposing to complete the installation. We recommend that the shoring be designed by an engineer licensed in Washington, and the PE stamped shoring plans and calculations be submitted to the engineer prior to construction.

5.9.4.3 TEMPORARY SHORING – SHEETPILES

We recommend that a shoring system be used where excavations are located adjacent to existing utilities, roadways, or structures where soil movement or ground loss could result in damage to these facilities. Unshored excavations should not encroach within a 1H:1V projection of bottom of existing footings. Shored excavations should include appropriate surcharges from footings located within 1H:1V projection of the bottom of existing footings.

We anticipate that construction of the Sludge Tank will be completed using at least a partially shored excavation due to the depth of the excavation and the presence of groundwater. A sloped excavation may be feasible at some locations provided that aggressive dewatering is completed concurrently and space constraints will not prohibit relatively flat temporary slopes. A sheet pile system extending into the underlying clayey glacial drift at the site will retain the soils and serve as a groundwater cutoff to minimize the quantity of water that will need to be pumped and discharged. For deeper excavations, where the wall is greater than about 10 feet high, it may be necessary to use a row of tieback anchors or deadmen to resist the additional pressure due to hydrostatic pressures. We recommend that the shoring be designed by an engineer licensed in Washington, and the PE stamped shoring plans and calculations be submitted to the Engineer prior to construction. The following paragraphs present suggested design parameters based on conditions encountered at the site; however, as stated before, the contractor will be responsible for shoring design.

The soil conditions encountered within our explorations generally consist of existing fill and beach deposits overlying generally clayey glacial drift. Groundwater is assumed to be approximately 5 feet bgs. Earth pressure diagrams for sheet pile shoring are provided in Figure 7 for the project area.

5.9.5 Structural Fill

Structural fill materials should be free of debris, organic contaminants, and rocks or rock fragments larger than 6 inches or half the lift thickness, whichever is smaller. All fill placed within the building and pavement areas should be placed as structural fill. Structural fill should be placed in horizontal lifts not exceeding 10 inches in loose thickness or that necessary to obtain the specified compaction with the equipment used. Each lift must be thoroughly and uniformly compacted as previously recommended.

As the amount of fines (material passing the U.S. No. 200 sieve) increases in a soil it becomes more sensitive to small changes in moisture content. During wet conditions, adequate compaction becomes more difficult to achieve. Generally, soils containing more than about 5 percent fines by weight cannot be properly compacted when the moisture content is more than a few percent from optimum.

Sufficient earthwork monitoring and a sufficient number of in-place density tests should be performed to evaluate fill placement and compaction operations and to confirm that the required compaction is being achieved.

5.9.5.1 SUITABILITY OF ON-SITE MATERIALS

The on-site materials within much of the proposed excavation depth for below grade structures consist fill of variable composition including sand, silt, and clay, with limited quantities of cleaner sand (SP-SM and SP). Material excavated from below the water table will not be suitable for use as backfill unless the sand is allowed to drain.

Silty sand fill encountered during our explorations had moisture contents ranging from slightly above to well above optimum moisture content. This material is also highly moisture sensitive. In our opinion the silty sand encountered may be used at the time of construction if approved by the geotechnical engineer based on the field moisture content and intended use. If significant quantities of native or previously imported sand with silt (SP-SM) or sand (SP) are encountered, this material will also likely be suitable for general backfill. These materials will likely need to be moisture conditioned to achieve suitable compaction and additional compactive effort will be required. It may be necessary for the contractor to segregate materials in order to use on-site soils for backfill. For planning purposes in structural support areas below foundations and slab-on-grade, we recommend a select import fill where structural fill is required.

5.9.5.2 SELECT IMPORT FILL

If wet weather or the moisture content precludes the use of onsite materials structural fill, we recommend using a select import fill to complete the backfilling site excavations. The select import fill should consist of sand and gravel with a fines content less than 5 percent based on that portion passing the ¾-inch sieve. Suitable Washington State Department of Transportation (WSDOT) Standard Specifications include Gravel Borrow (9-03.14) minimum 30 percent on U.S No. 4 sieve and fines content limited as noted.

5.9.5.3 FILL PLACEMENT AND COMPACTION

Structural fill should be placed in 8- to 12-inch loose lifts, or that thickness necessary to achieve the required compaction using the mechanical equipment chosen by the contractor. We recommend that the MDD be estimated based on ASTM International (ASTM) D 1557.

Table 7 below provides a summary of recommended imported structural fill materials and compaction standards.

TABLE 7. SUGGESTED FILL MATERIAL COMPACTION AND SPECIFICATION

FILL AREA	COMPACTION	SUGGESTED SPECIFICATION
Structural fill below foundations	95% MDD	WSDOT Gravel Borrow 9-03.14(1) with minimum 30 percent on U.S No. 4 sieve; or WSDOT Crushed Surfacing 9-03.9(3)
Retaining wall backfill	90 to 92% MDD within 5 feet of wall	WSDOT Gravel Borrow 9-03.14(1); or WSDOT Gravel Backfill for Drains 9-03.12(4)
Structural fill below pavements, driveways, and sidewalk	90% MDD except 95% in upper two feet below pavement section	WSDOT Gravel Borrow 9-03.14(1)
Gravel base for pavement	95% MDD	WSDOT Aggregate for Gravel Base 9-03.10
Crushed surfacing base/top course	95% MDD	WSDOT Crushed Surfacing 9-03.9(3)

Notes:
AASHTO - American Association of State Highway and Transportation Officials

5.9.6 Wet Weather Earthwork and Erosion Control

General recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. These recommendations should be incorporated into the contract specifications.

- Earthwork should be performed to limit exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement and compaction of clean fill. The size and type of construction equipment used may need to be limited to prevent soil disturbance.
- The ground surface within the construction area should be sealed by a smooth drum vibratory roller, or equivalent, and under no circumstances should soil be left uncompacted and exposed to moisture that can erode off the jobsite.
- Excavation and placement of structural fill and trench backfill material should be performed under sufficient observation and testing to confirm that the work is completed in accordance with the project specifications and the recommendations contained herein.
- Soil stockpiles should be covered with plastic sheeting if wet weather conditions are anticipated.
- Silt fences should be installed between the work area and sensitive areas to prevent transport of sediment beyond the work area.

5.10 CONSTRUCTION DEWATERING

The excavations for the Sludge Tanks and some excavations for utility piping will likely extend to near or below the groundwater table during most times of the year. Zones of seepage will likely be encountered in other shallower excavations and for excavation of the below grade sludge tank foundation. Where temporary construction slopes with open cuts will be used, we expect that a combination of open pumping and well points will be required to adequately dewater site soils. It is likely that sumps and pumps with limited shoring will be sufficient to dewater if the water level needs to be lowered only a few feet. Extensive dewatering of compressible soils can increase effective stresses in the soil and induce settlement. The Contractor should have the responsibility to determine the dewatering measures needed for the project.

5.10.1 Open Pumping

This dewatering method involves removing water that has seeped into the excavation by pumping from a sump that has been excavated at one end of the excavation or trench. Drainage ditches that are connected to the sump are typically excavated along the sidewalls at the base of the excavation or trench. The excavation for the sump and the drainage ditches should be backfilled with gravel or crushed rock to reduce the amount of erosion and associated sediment in the water pumped from the sump. In our experience, a slotted casing, perforated 5-gallon bucket or 55-gallon drum that is installed in the sump backfill provides a suitable housing for a submersible pump.

The amount of water removed from the excavation by open pumping should be minimized because of high turbidity levels. Temporary storage of dewatering effluent from the sumps in a settlement tank or basin may be required to meet National Pollution Discharge Elimination System (NPDES) construction storm water discharge permit requirements and reduce sediment content prior to discharging the water to surface water courses.

5.10.2 Wellpoints

Wellpoints are effective for dewatering all types of soils, whether pumping small amounts of water from silt or large quantities of water from coarse sand and gravel. The volume of water generated by a wellpoint system is typically less than the volume generated by a corresponding system of pumped wells because the wellpoints are generally completed at a shallower depth. Because of the shallower completion depth, the volume of aquifer that contributes water to a wellpoint system is less than for a comparable deep well system. In our opinion, well points will be a more effective dewatering system than pumped wells, given the site conditions. Wellpoint systems are most suitable for dewatering shallow excavations where the water table must be lowered no more than about 15 feet below ground surface or the header surface. Multiple wellpoint stages are generally required beyond that depth because of the physical limitations of suction lift. Dewatering can be accomplished at depths greater than 15 feet where the excavation can be open cut to permit installation of the wellpoint header system below original grade. This technique increases the depth to which the water table can be lowered with wellpoints. The wellpoints would likely need to be installed on less than 10-foot centers (typically 4 to 8 feet) to be effective and as close as possible to the edge of the excavation. The wellpoint screens should be filter packed with graded sand or sand and fine gravel to improve pumping efficiency and minimize the discharge of turbid water. Wellpoints must be sealed to a depth of at least 8 feet with hydrated bentonite chips forming a surface seal to encourage the development of a partial vacuum around each wellpoint.

5.10.3 Dewatering Qualifications and Experience

We strongly recommend that dewatering, where used, be performed by a contractor or subcontractor with dewatering experience. If necessary to use well points, we recommend an experienced dewatering specialist contractor with competent and experienced staff who can demonstrate successful deployment and operation of vacuum wellpoint systems in the Pacific Northwest over the past 10 years, and who can install systems that use high capacity electronically controlled and monitored vacuum pumps. If active dewatering using wells or wellpoints will be used, we recommend a Dewatering Plan be required as a submittal from the contractor at least two weeks prior to dewatering, that fully describes the dewatering approach, including material and equipment specifications, calculations, and supporting assumptions to ensure that dewatering is achieved to not less than 1 foot below excavation subgrade. The Dewatering Plan should include an appropriate survey program identifying critical infrastructure that will be monitored, schedule of survey times, and appropriate action plans if subsidence is observed. The Dewatering Plan should be prepared by or under the direct supervision of a Professional Engineer and/or Licensed hydrogeologist registered in the State of Washington and having at least 5 years of demonstrated experience in the design and operation of vacuum wellpoint dewatering systems.

5.10.4 Dewatering Limitations

Our services were provided to assist in the assessment of construction dewatering requirements for the planned wastewater treatment plant expansion project. Our dewatering recommendations are based on evaluation of the available geotechnical information. Groundwater can create a safety threat and can seriously compromise arrangements for shoring excavations. Also, given the potential for natural variation in geologic formations, differing site conditions may be encountered that could lead to substantially different groundwater inflows and dewatering challenges than are presented in this evaluation. We did not perform pumping tests or other detailed hydrogeologic evaluations and this information is presented for use by the contractor but is not intended to dictate designs.

5.11 DRAINAGE CONSIDERATIONS

The existing near surface site soils consist of fill from previous peat removal. The groundwater elevation varies by season and was observed at approximately 5 feet bgs based on information in available environmental reports. The existing WWTP infrastructure includes a below grade utilidor in the adjacent roadway. Based on all these factors, stormwater infiltration does not meet feasibility criteria. We anticipate that stormwater will be routed to existing collection systems.

6.0 Geotechnical Design and Construction Observation Services

The project has variable subsurface conditions and some complex geotechnical issues. We recommend that GeoEngineers provide consultation during final design and monitoring during construction. It is our experience that providing geotechnical support to the design team during final design, bidding, preconstruction meetings, and during construction facilitates the contractor, progress, and schedule, and helps protect the owner from change orders. On this project, we recommend geotechnical involvement in at least the following aspects of the project:

- Final design of project structures
- Review of pile foundation or ground improvement plans
- Review of shoring submittal and observation during construction
- Review of dewatering plan and consultation during construction
- Approval of backfill materials and sources
- Observation of pile or ground improvement installation, as necessary
- Evaluation of subgrade conditions for shallow foundation support
- Evaluation of subgrade conditions for pipeline, pavement, and other infrastructure
- General consultation to the owner, design team and contractor, as requested

7.0 Limitations

We have prepared this report for use by the City of Bellingham, Carollo Engineers and their authorized agents for the proposed Post Point Primary Sludge Tank Replacement located in Bellingham, Washington.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

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8.0 References

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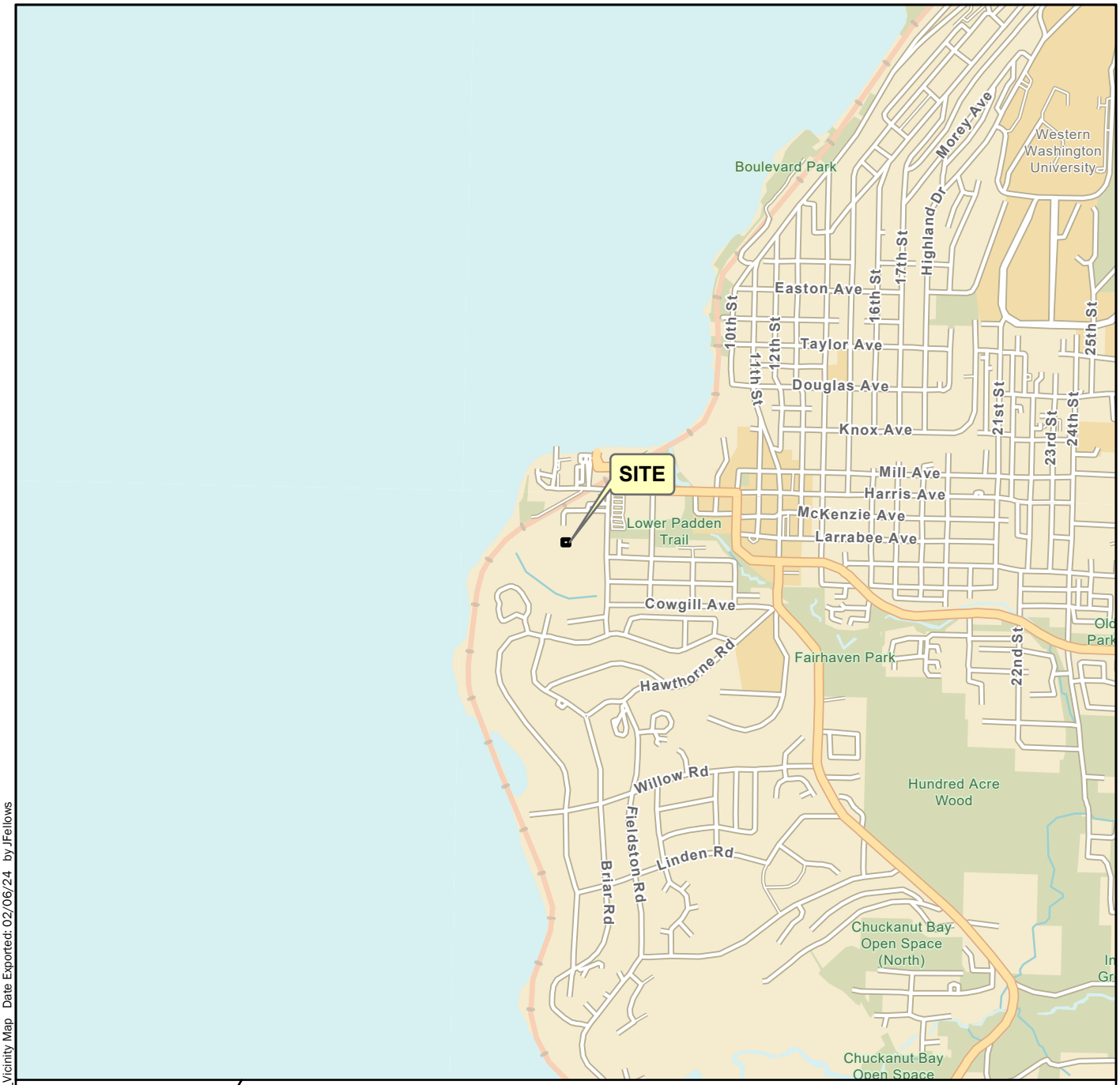
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Figures



Source(s):
- ESRI

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

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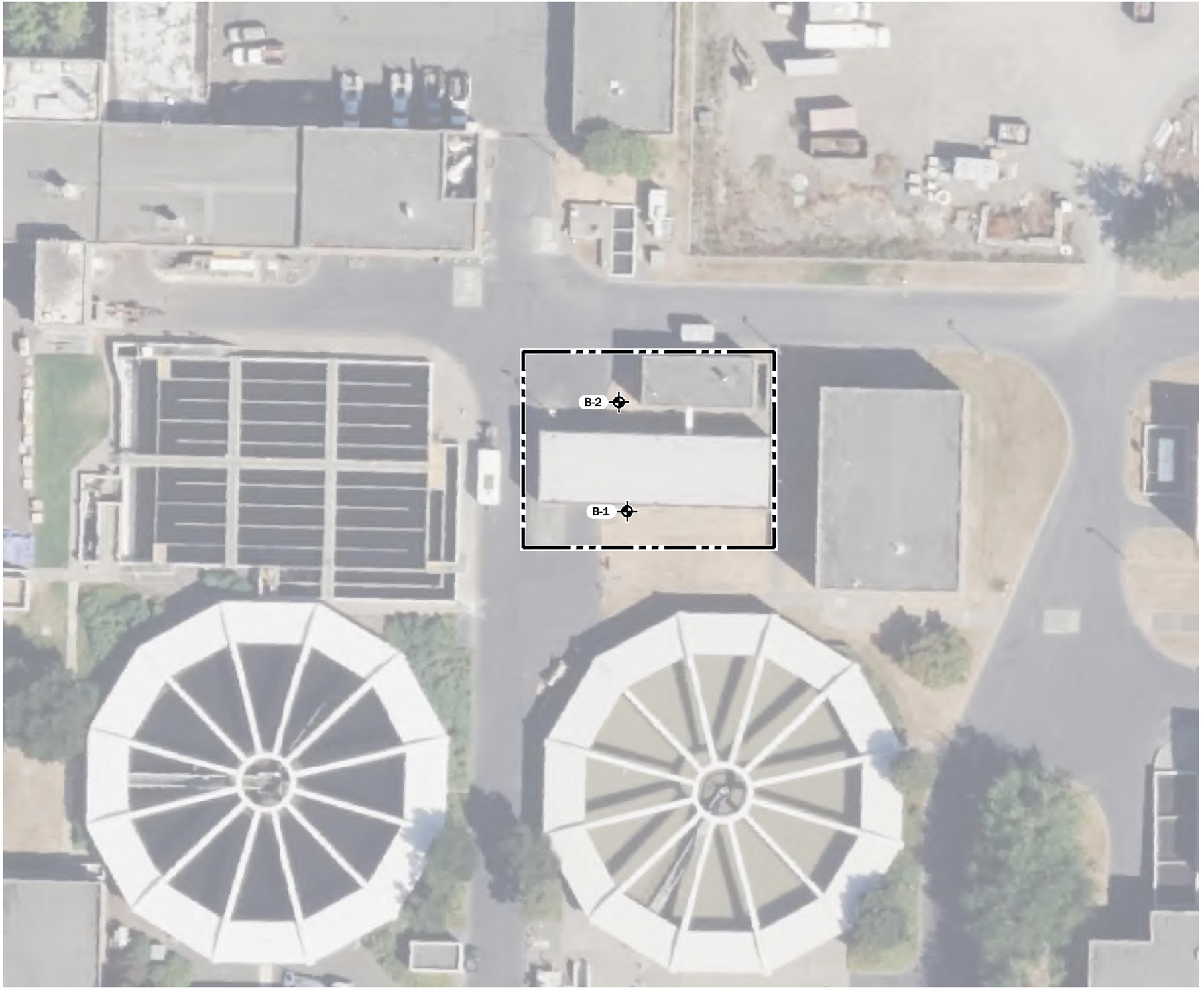
Vicinity Map

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

GeoEngineers

Figure 1

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Legend

Site Boundary

B-1 Boring by GeoEngineers, Inc., 2023

Source(s):

- Aerial from Microsoft Bing

Projection: WA State Plane, North Zone, NAD83, US Foot

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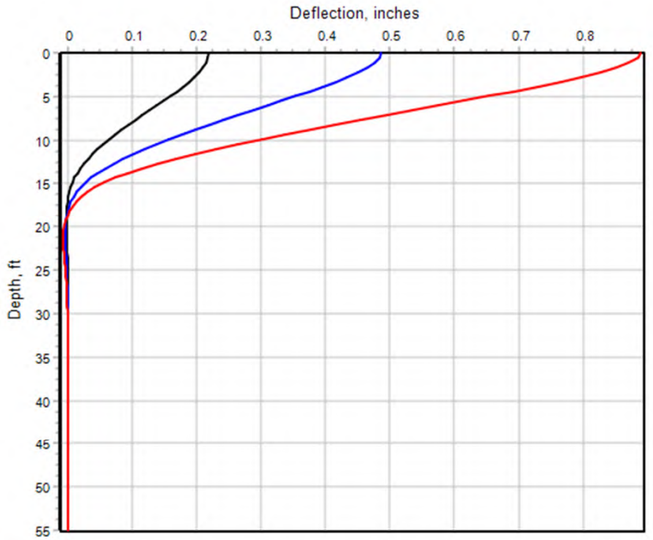
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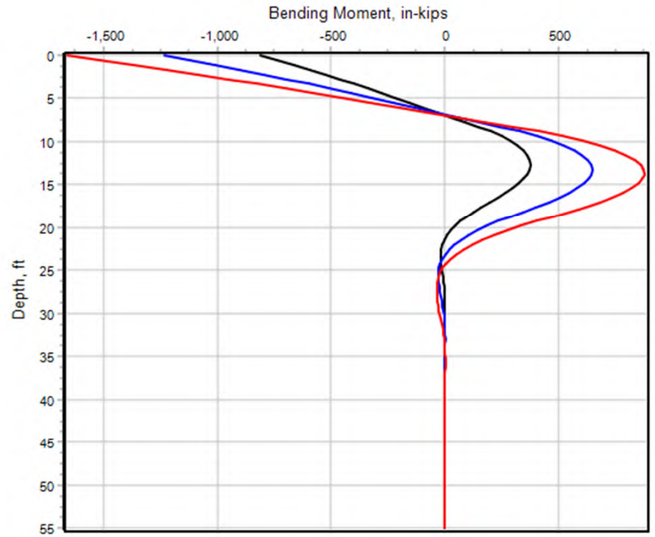
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Bellingham, Washington

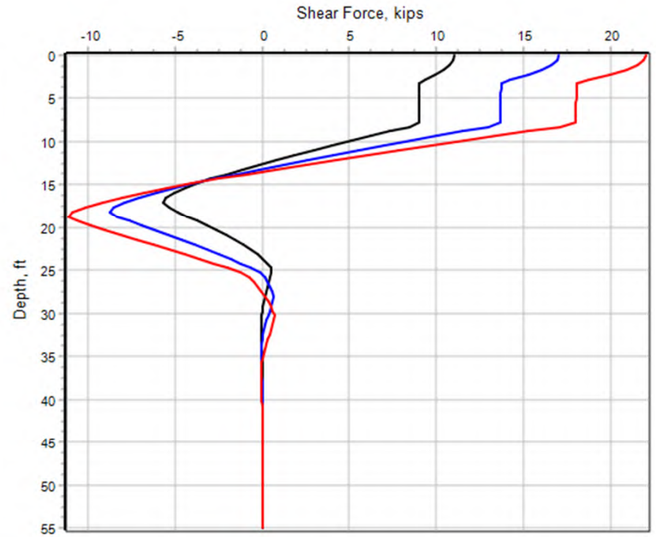
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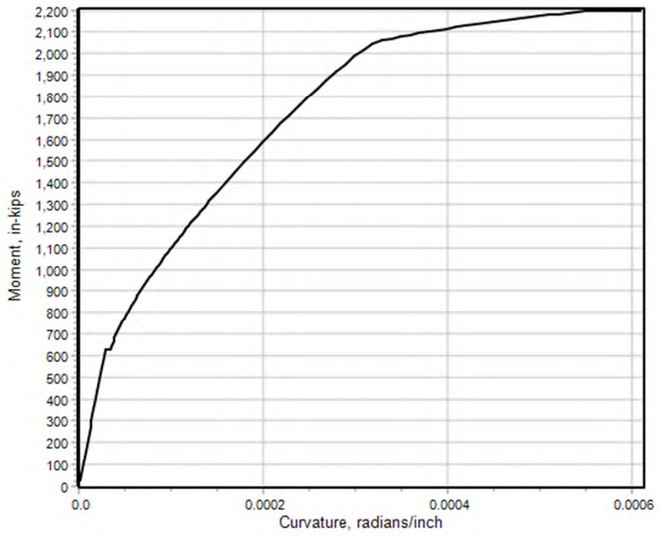
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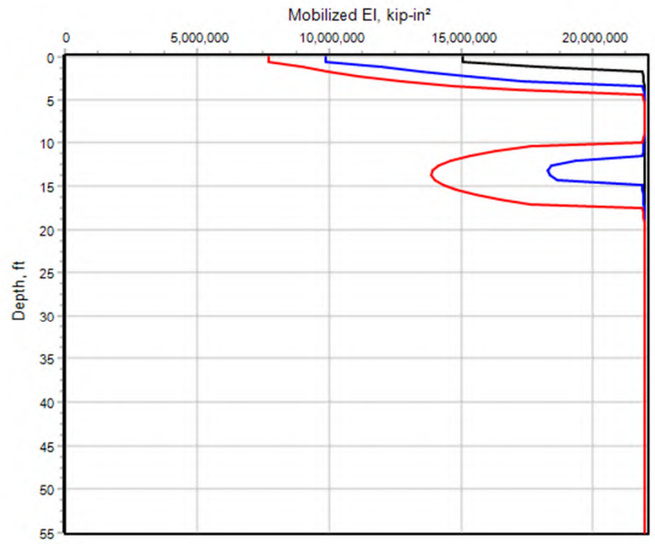
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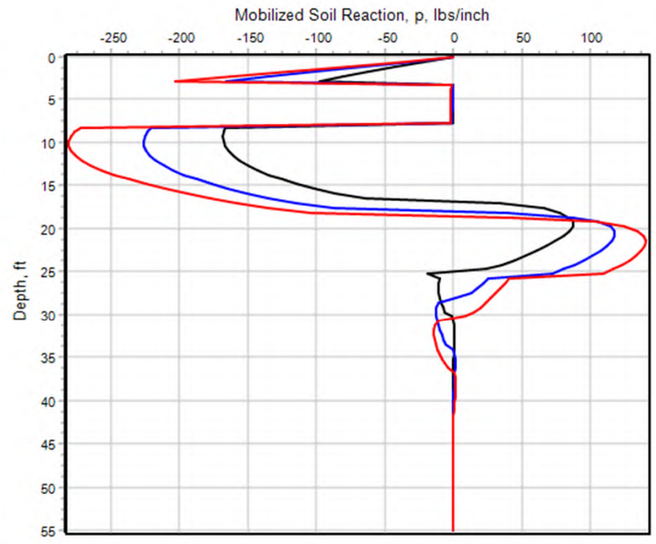












Assumptions

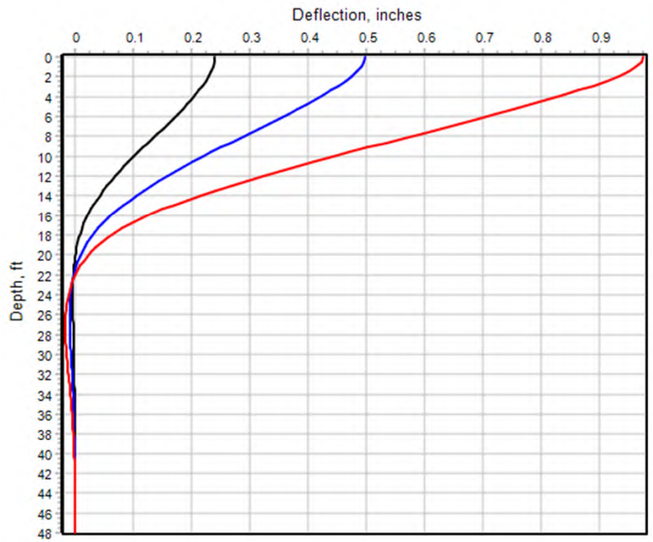
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- Fixed-head condition
- Horizontal ground surface
- Single shaft with no group effects or p-multipliers
- 170 Kip vertical load, 11, 17 and 22 Kip lateral loads

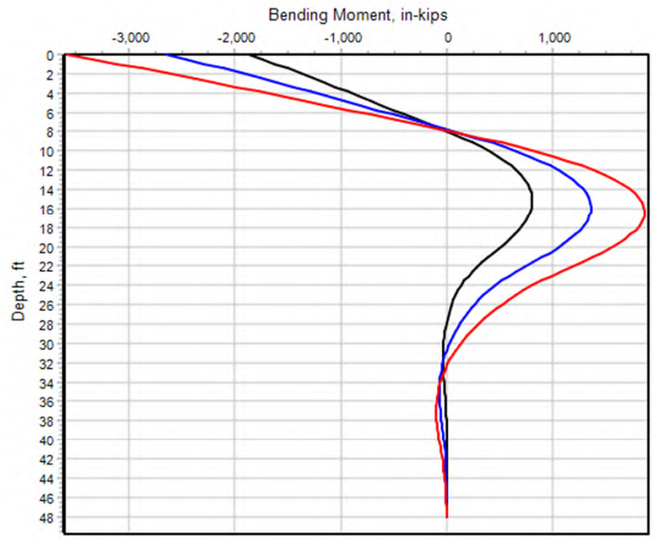
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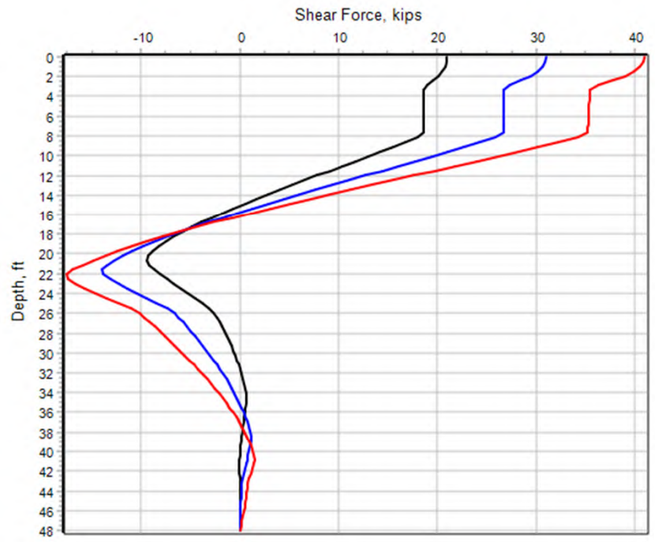
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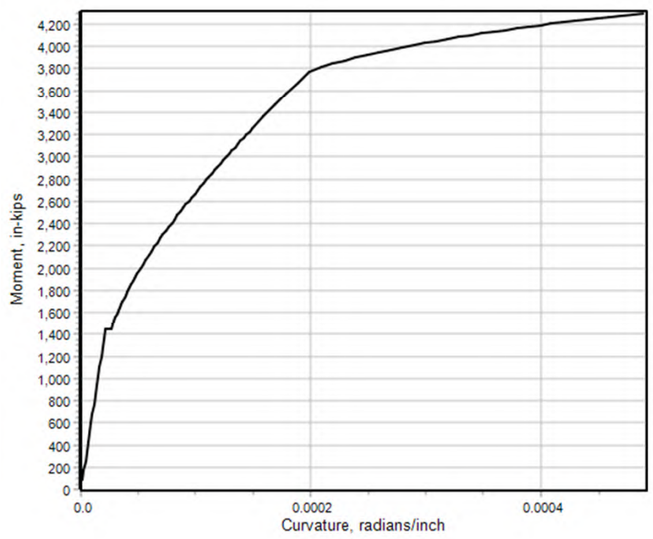
Post Point Sludge Tank Replacement
Bellingham, Washington

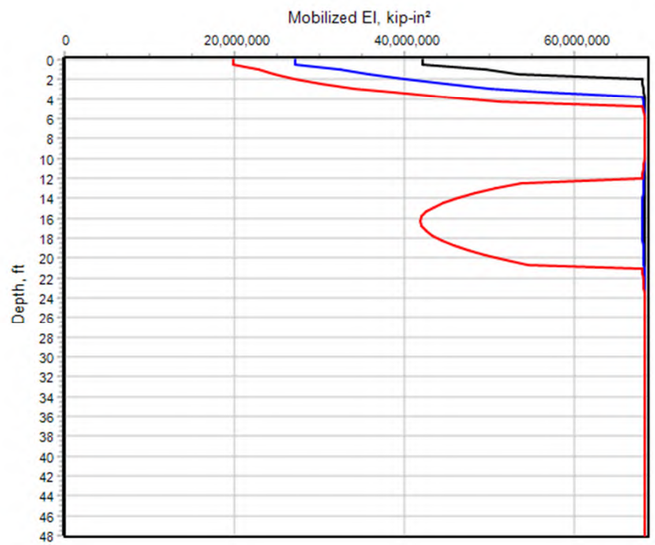
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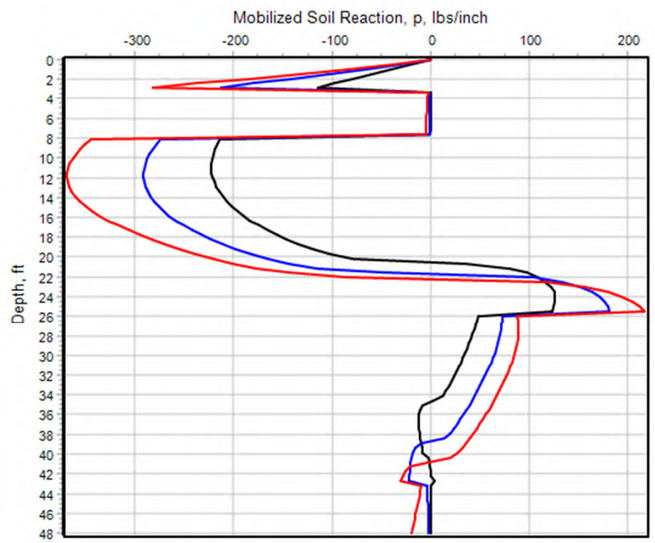












Assumptions

- 2-foot diameter Round Concrete Shaft (Bored Pile)
- 4,500 psi Concrete with 1% Steel Reinforcement
- Fixed-head condition
- Horizontal ground surface
- Single shaft with no group effects or p-multipliers
- 270 Kip vertical load, 21, 31 and 41 Kip lateral loads

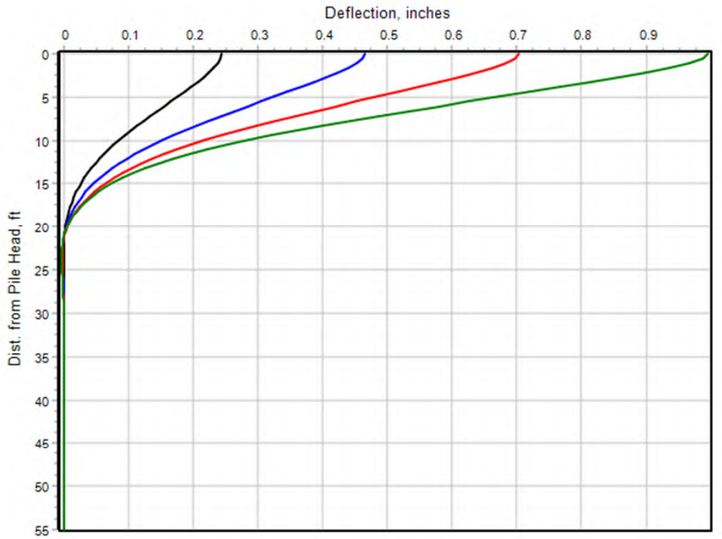
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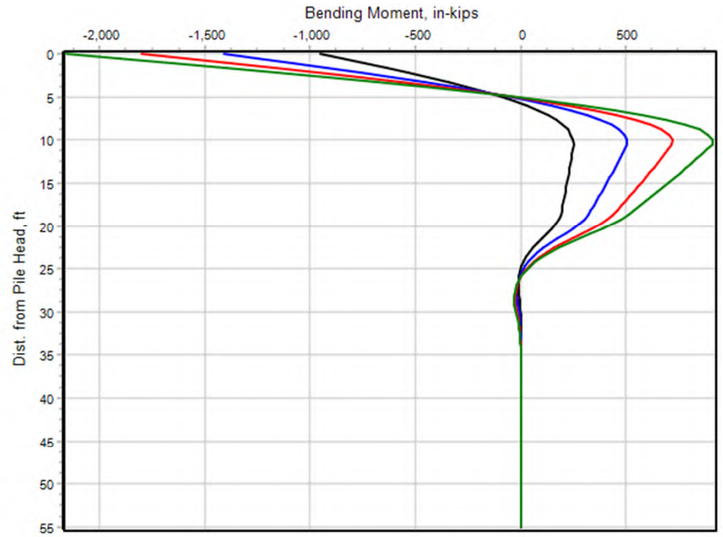
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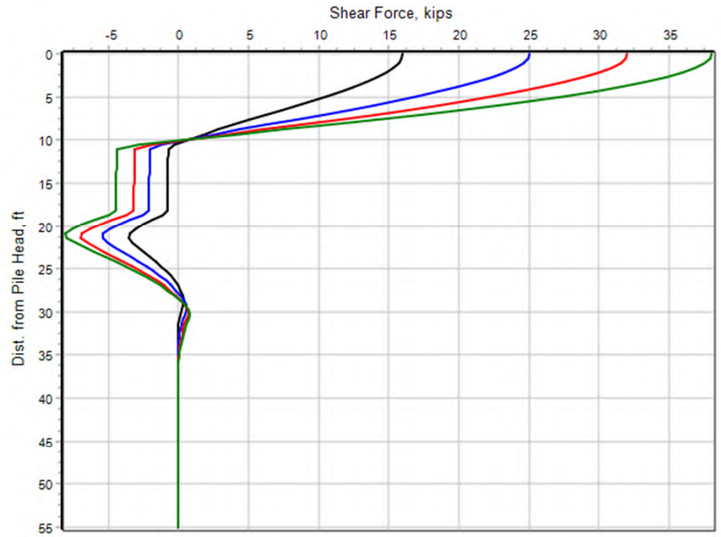
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Bellingham, Washington

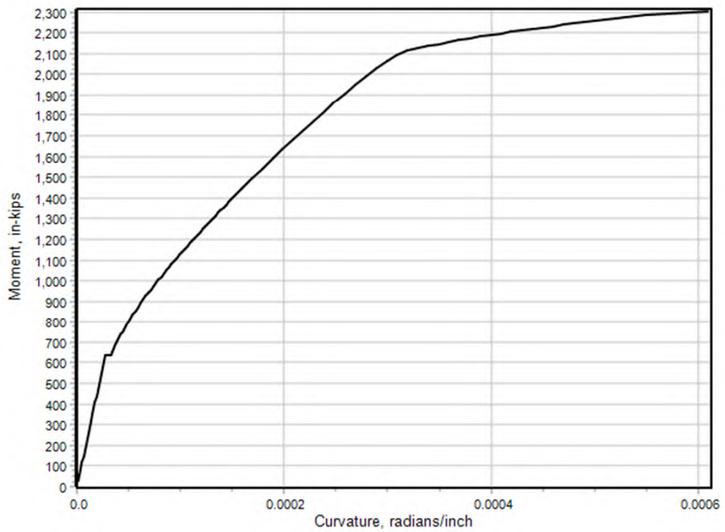
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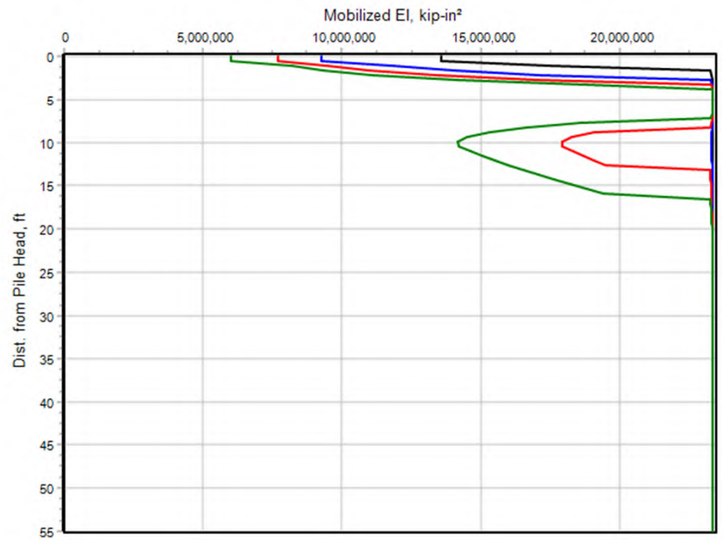
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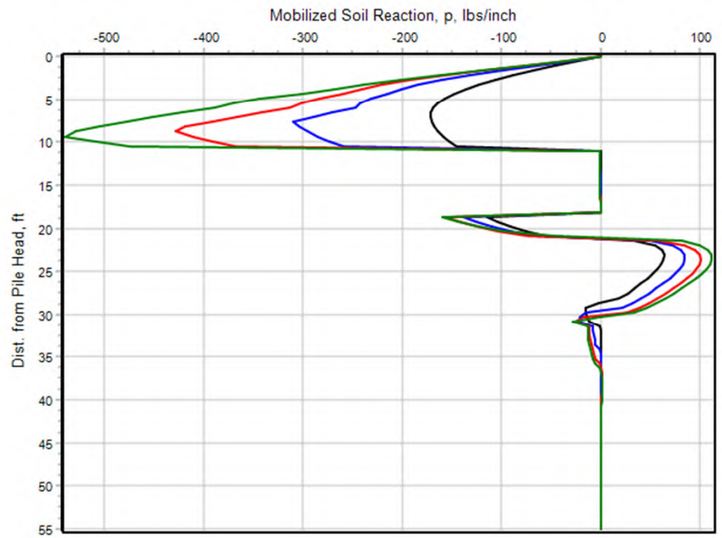












Assumptions

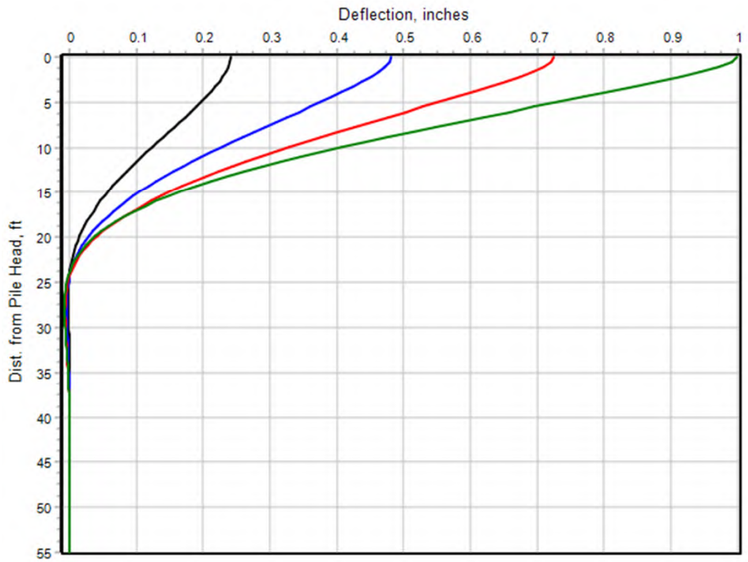
- 1.5-foot diameter Round Concrete Shaft (Bored Pile)
- 4,500 psi Concrete with 1% Steel Reinforcement
- Fixed-head condition
- Horizontal ground surface
- Single shaft with no group effects or p-multipliers
- 270 Kip vertical load, 16, 25, 32, and 38 Kip lateral loads

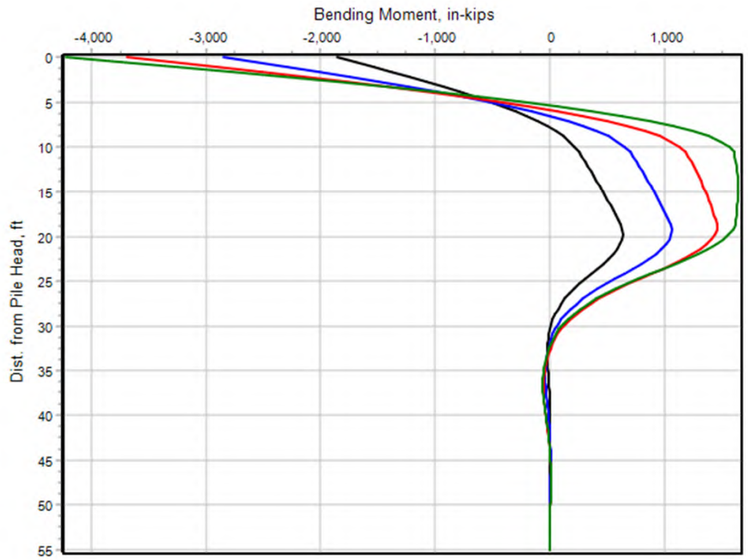
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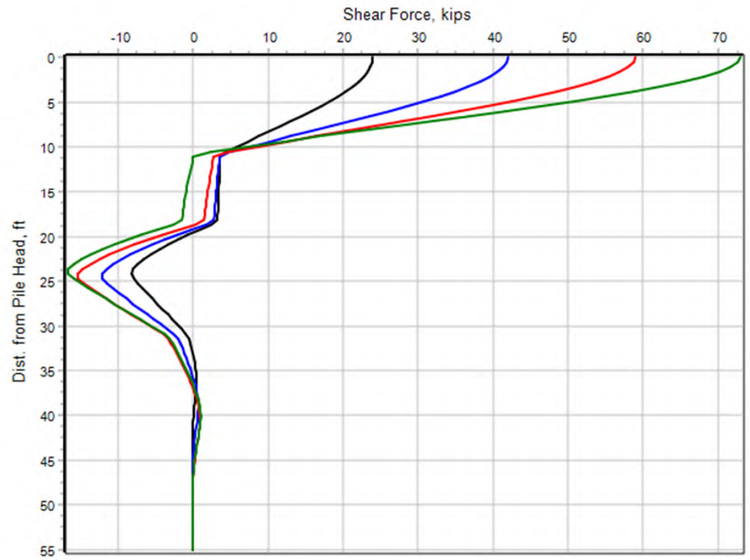
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Fixed Head – At Grade - Odor Control Slab

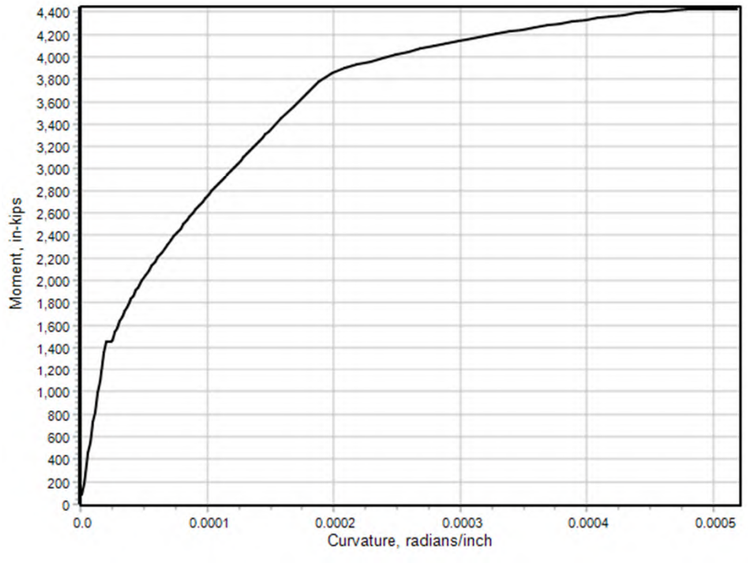
Post Point Sludge Tank Replacement
Bellingham, Washington

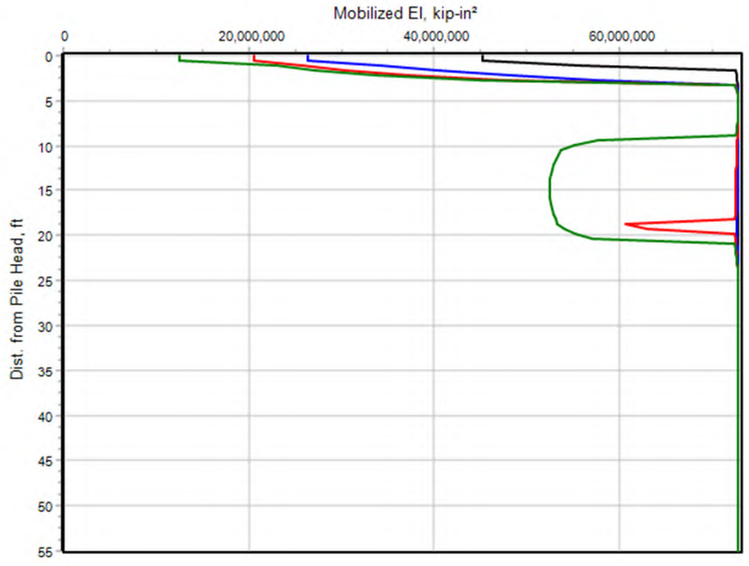
GeoEngineers | **Figure 5**

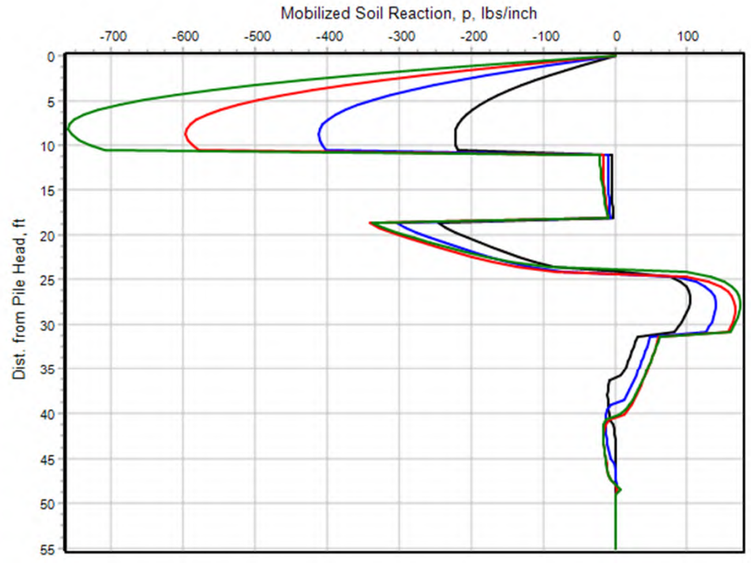












Assumptions

- 2-foot diameter Round Concrete Shaft (Bored Pile)
- 4,500 psi Concrete with 1% Steel Reinforcement
- Fixed-head condition
- Horizontal ground surface
- Single shaft with no group effects or p-multipliers
- 270 Kip vertical load, 24, 42, 59, and 73 Kip lateral loads

Reference: LPILE v2019.11.02 (Ensoft)

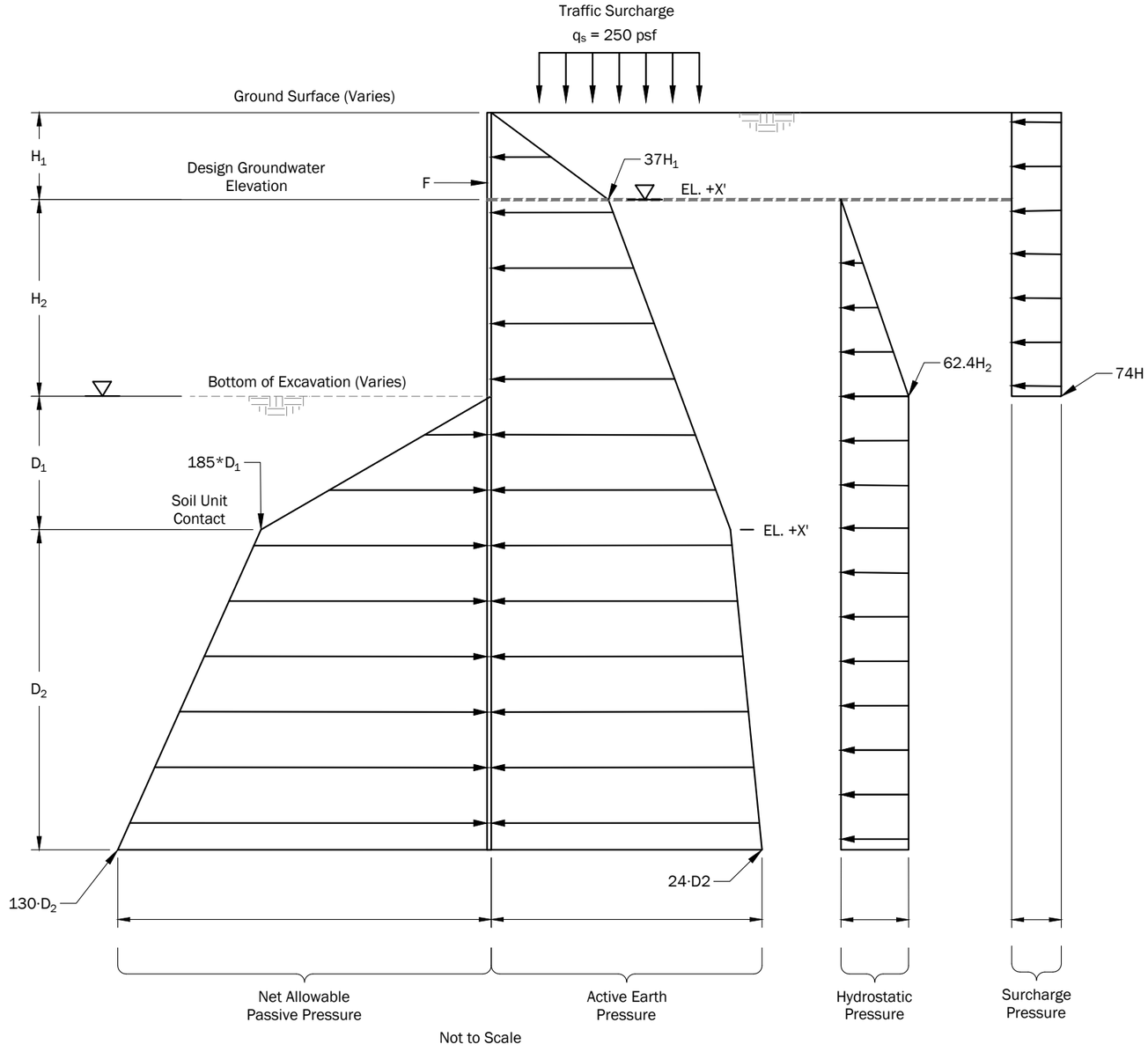
LPile Output Plots – 24-inch Diameter Shaft
Fixed Head - At Grade – Odor Control Slab

Post Point Sludge Tank Replacement
Bellingham, Washington

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Figure 6

Temporary Sheetpile Shoring



Not to Scale

Note(s):

1. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

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Legend

- ▽ Design Groundwater Elevation
- H_1 = Height of excavation above design groundwater elevation
- H_2 = Height of excavation below design groundwater elevation
- D_1 = Depth of sheet pile embedment between bottom of excavation and soil unit contact
- D_2 = Depth of sheet pile embedment soil unit contact and bottom of sheet pile

Earth Pressure Diagram
Temporary Sheet Pile Wall

Post Point Sludge Tank Improvements
Bellingham, Washington

GeoEngineers

Figure 7

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Appendices

Appendix A
Field Explorations and Laboratory Testing

Appendix A
Field Explorations and Laboratory Testing

Subsurface soil and groundwater conditions at the site were evaluated by drilling two borings (B-1-23 and B-2-23). The borings were drilled to depths of 16½ and 61½ feet below the existing ground surface (bgs) and were completed on July 27, 2023, using a track-mounted drill rig subcontracted to GeoEngineers. The locations and elevations of the explorations were estimated in the field based on taping and pacing from relevant site features shown in a site survey drawing by Wilson Engineering. The approximate exploration locations are shown in the Site and Exploration Plan, Figure 2.

The soils encountered in the borings were generally sampled at 2½- or 5-foot vertical intervals with a 2-inch outside diameter split-barrel standard penetration test (SPT) sampler. Disturbed soil samples were obtained by driving the samplers 18 inches into the soil with a 140-pound rope and cathead hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions preclude driving the full 18-inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown on the boring logs at the respective sample depths.

The explorations were continuously monitored by a geotechnical scientist or geologist from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared a detailed log of each exploration. Soils encountered were classified visually in general accordance with ASTM International (ASTM) D-2488, which is described in Figure A-1. An explanation of our boring log symbols is also shown in Figure A-1.

The logs of the borings are presented in Figures A-2 through A-3. The exploration logs are based on our interpretation of the field and laboratory data and indicate the various types of soils encountered. They also indicate the depths at which these soils or their characteristics change, although the change might actually be gradual. If the change occurred between samples in the exploration, it was interpreted.

LABORATORY TESTING

Soil samples obtained from the explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of the determination of the moisture content, percent fines, sieve analysis, and Atterberg Limit determinations. The tests were performed in general accordance with test methods of the ASTM or other applicable procedures.

Moisture Content Testing

The natural moisture contents of selected soil samples obtained from the exploratory borings were estimated in general accordance with ASTM D 2216 test procedures. The results from the moisture content determinations are displayed shown on the exploration logs in Appendix A in the column labeled "Moisture Content (%)" adjacent to the corresponding samples.

Percent Passing U.S. No. 200 Sieve

Selected samples were "washed" through the U.S. No. 200 mesh sieve to determine the relative percentage of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted in general accordance with ASTM D 1140. The results from the percent fines determinations are displayed in the column labeled "Fines Content (%)" adjacent to the corresponding samples on the summary exploration logs.

Sieve Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 6913 to determine the sample grain size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted, classified in general accordance with the Unified Soil Classification System (USCS), and are presented in Figure A-4.

Atterberg Limits Testing

Atterberg limit tests were performed on selected soil samples. The tests were used to classify the soil as well as to aid in estimating index properties and consolidation characteristics of the fine-grained soil deposits. The liquid limit and the plastic limit were estimated through a procedure in general accordance with ASTM D 4318. The results of the Atterberg limits testing are summarized in Figure A-5 and on the attached boring logs at their respective sample depths.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

Modified California Sampler (6-inch sleeve) or Dames & Moore

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point load test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers

Figure A-1

Drilled Start 7/27/2023 End 7/27/2023	Total Depth (ft) 16.5	Logged By KLL Checked By AJH	Driller Boretec, Inc.	Drilling Method Hollow-stem Auger	
Surface Elevation (ft) 20 Vertical Datum NAVD88		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment EC 95 Track Drill	
Latitude 48.7180961 Longitude -122.5138228		System Datum Decimal Degrees WGS84		Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0					1		SM	Brown silty fine to medium sand with occasional gravel and occasional cobbles (loose, moist) (fill)			
			16	14		2 %F		SP-SM	Gray medium to coarse sand with silt (medium dense, moist)	18	12	
-5	5		4	28		3						
			17	10		4 SA		SM	Gray silty fine to medium sand with gravel (medium dense, moist)	10	26	
-10	10		4	14		5			With shell fragments			
			16	13		6 %F		SM	Gray silty fine to medium sand with gravel and occasional black organic matter (medium dense, moist)	20	22	
-15	15		1	50/4"		7						Blow counts overstated on gravel

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Boring B-1-23

GeoEngineers

Project: Post Point Primary Sludge Tank Replacement
Project Location: Bellingham, Washington
Project Number: 0356-185-00

Figure A-2
Sheet 1 of 1

Date:12/19/24 Path:P:\0\0356185\GINT\035618500.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW

Drilled Start 7/27/2023 End 7/27/2023	Total Depth (ft) 61.5	Logged By KLL Checked By AJH	Driller Boretec, Inc.	Drilling Method Hollow-stem Auger	
Surface Elevation (ft) 20 Vertical Datum NAVD88		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment EC 95 Track Drill	
Latitude 48.718216 Longitude -122.5138369		System Datum Decimal Degrees WGS84		See "Remarks" section for groundwater observed	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0				1		SM	Brown silty fine to medium sand with gravel and occasional cobbles (loose, moist) (fill)			
		16	16		2 SA		SM	Dark brown silty fine to coarse sand with gravel and occasional iron-staining; 1-inch lenses of gray clayey sandy silt (medium dense, moist)	10	19	
-15	5	12	18		3 MC				9		
		18	24		4 MC		SM	Gray silty fine to coarse sand with gravel (medium dense, moist)	11		
-10	10	10	24		5 MC				11		
		18	9		6 %F			Becomes loose	12	24	
-5	15	18	6		7 MC		SM	Gray silty fine to medium sand with shell fragments (loose, moist) (beach deposits)	21		
0	20	18	16		8 MC		CL	Gray clay (very stiff, moist) (glaciomarine drift)	29		
-5	25	18	10		9 MC			Becomes stiff, wet	24		Groundwater observed at approximately 25 feet below ground surface during drilling
-10	30	18	8		10 AL				33		AL (LL = 46; PI = 26)
-15	35										

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Date:12/19/24 Path:P:\0\0356185\GINT\035618500.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIB_GEOTECH_STANDARD_%F_NO_GW

Log of Boring B-2-23

GeoEngineers

Project: Post Point Primary Sludge Tank Replacement
Project Location: Bellingham, Washington
Project Number: 0356-185-00

Figure A-3
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	FIELD DATA: Blows/foot	FIELD DATA: Collected Sample	FIELD DATA: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35	18	3		11 AL			Becomes soft	24		AL (LL = 25; PI = 17)
-20	40	18	11		12 MC		CL	Gray silty clay with sand (stiff, wet)	20		
-25	45	18	20		13 MC				22		
-30	50	18	49		14 %F		SM	Gray silty sand (dense, wet) (glacially consolidated soils)	17	21	
-35	55	18	67		15 %F		GP-GM	Gray fine to coarse gravel with sand and silt (very dense, wet)	11	9	
							SP-SM	Gray medium to coarse sand with silt (very dense, wet)			
-40	60	18	83		16 %F				13	11	

Date:12/19/24 Path:P:\0\0356185\GINT\035618500.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIB_GEOTECH_STANDARD_%F_NO_GW

Log of Boring B-2-23 (continued)

GeoEngineers

Project: Post Point Primary Sludge Tank Replacement
Project Location: Bellingham, Washington
Project Number: 0356-185-00

Figure A-3
Sheet 2 of 2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	B-1-23	7.5	10	Silty sand with gravel (SM)
■	B-2-23	2.5	10	Silty sand with gravel (SM)

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The grain size analysis results were obtained in general accordance with ASTM D 6913. GeoEngineers 17425 NE Union Hill Road Ste 250, Redmond, WA 98052

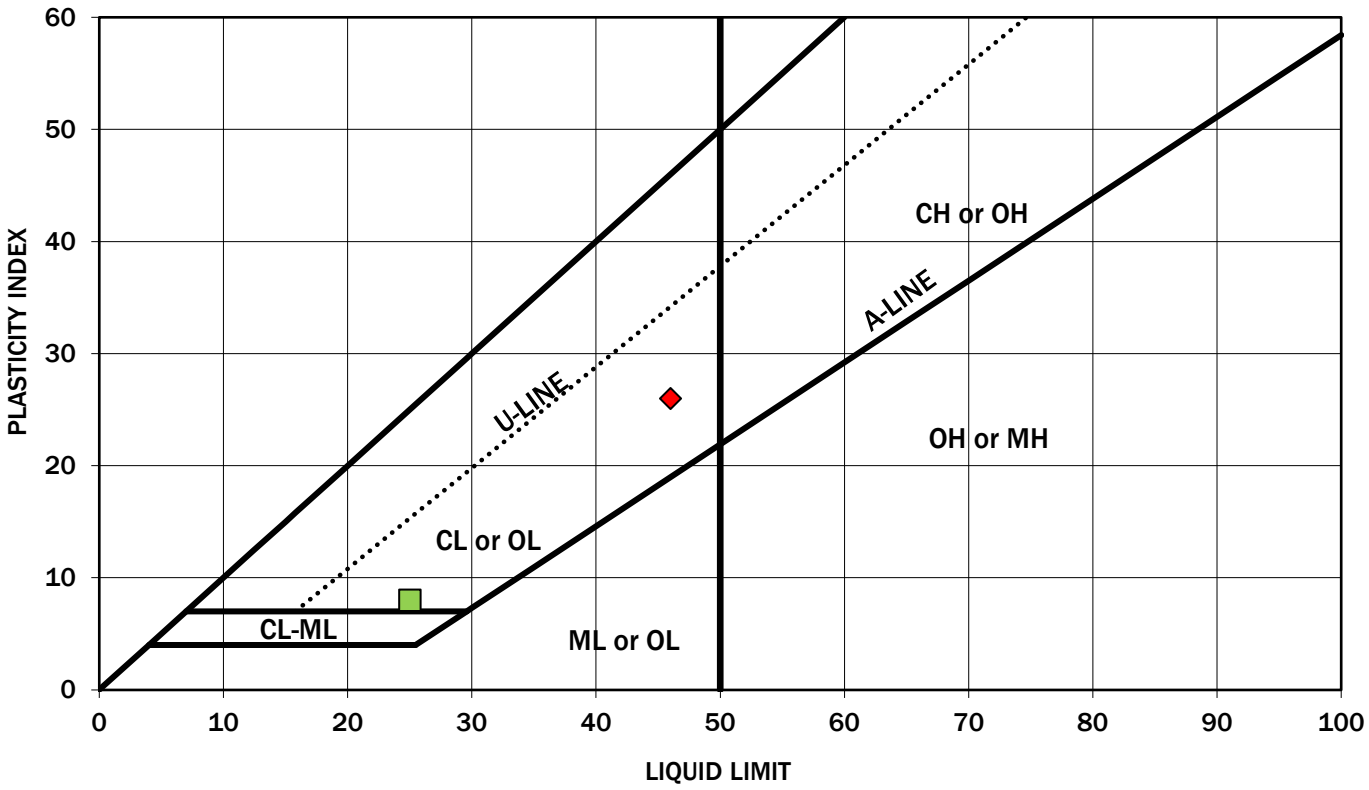
GEOENGINEERS

Figure A-4

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

Sieve Analysis Results

PLASTICITY CHART



Symbol	Boring Number	Depth (feet)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Soil Description
◆	B-2-23	30	33	46	26	Clay (CL)
■	B-2-23	35	24	25	17	Clay (CL)

Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes. The liquid limit and plasticity index were obtained in general accordance with ASTM D 4318. GeoEngineers 17425 NE Union Hill Road Ste 250, Redmond, WA 98052

Atterberg Limits Test Results

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

GeoEngineers

Figure A-5

0356-185-00 Date Exported: 08/09/2023

Appendix B
Outside Laboratory Testing

Appendix B
Outside Laboratory Testing

Corrosion potential of selected soil samples was conducted based on laboratory chemical testing subcontracted to Norton Corrosion of Woodinville, Washington. Laboratory testing included pH, chloride, sulfate, sulfide, redox potential, and resistivity, the results of which are summarized in Table 6 in the report. Test results are also presented on the following summary page.

NORTON CORROSION LIMITED

CORROSION EVALUATION
DUCTILE IRON PIPE

DATA SHEET: 1 OF 1
NCL JOB #: E-24432
DATE IN: 29 JAN 2024
DATE OUT: 09 FEB 2024
BY: H. DUFFY

SOIL ANALYSIS

STOMER: Geo Engineers
ROJECT: Post Point Sludge Tank
JOB #: 0356.185-00

NCL SAMPLE NO.	SAMPLE I.D.	Soil Wt. Native	Soil Wt. Dry	% MOISTURE	pH	SULFIDE SCREEN (ppm)	RESISTIVITY (Ω-CM) NATIVE	RESISTIVITY (Ω-CM) SATURATED	REDOX (mV)	DIPRA SCORE	CHLORIDE (ppm)	SULFATE (mg/L)
1	B-1 S-2 2.5'	27.857	25.991	6.70	5.9	ND*	8,700	3,800	104.2	0	93	32
2	B-1 S-4 7.5'	25.070	24.070	3.99	7.0	ND*	43,000	7,100	151.2	0	<30	33
3	B-2 S-2 2.5'	25.821	24.615	4.67	6.6	ND*	73,000	15,000	140.5	0	<30	IS**
4	B-2 S-4 7.5'	29.355	26.727	8.95	6.9	ND*	9,800	5,000	173.2	0	<30	<2
5												
6												
TESTING METHOD					ASTM 4972	EPA 9030B	ASTM G-57	ASTM G-57	ASTM D1498		EPA 300.0	EPA 300.0

ND* Analyte NOT DETECTED at or above the reporting limit
IS** Insufficient sample to run test

Appendix C
Report Limitations and Guidelines for Use

Appendix C
Report Limitations And Guidelines For Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for Carollo Engineers, Inc., the City of Bellingham, and for the Project(s) specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our Agreement with Carollo Engineers, Inc. authorized by Susanna Leung on July 12, 2023, and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the proposed Post Point Sludge Tank Replacement Project to be located in Bellingham, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

[1]Developed based on material provided by GBA, GeoProfessional Business Association; www.geoprofessional.org.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers

cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to conduct additional study to obtain the specific types of information they need or prefer.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

APPENDIX B.6 EXHIBIT C:
STORMWATER ENGINEERING REPORT
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

Post Point Primary Sludge Tank Replacement Project
200 McKenzie Ave, Bellingham, WA 98225

STORMWATER ENGINEERING REPORT

Prepared by:
WILSON ENGINEERING
805 Dupont Street
Bellingham, WA. 98225
(360) 733-6100

Prepared for:
City of Bellingham
210 Lottie Street
Bellingham, WA 98225
(360) 778-7900

Wilson Project No. 2023-070
October 7th, 2024



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1.3 Developed Conditions 4
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APPENDIX A - Vicinity Map

APPENDIX B – Geotechnical Report

APPENDIX C – TESC Plans – Permit Set

APPENDIX D – Basin Map

APPENDIX E – Stormwater Plans – Permit Set

APPENDIX F – Hydraulic Calculations

APPENDIX G – FEMA Flood Map

1.0 PROJECT OVERVIEW

Project Owner:	City of Bellingham 210 Lottie Street Bellingham, WA 98225 (360) 778-7900
Civil Engineer:	Wilson Engineering, LLC 805 Dupont Street Bellingham, WA 98225 (360) 733-6100 x1235 Contact: Paul Thomas, P.E.

This stormwater report describes measures to be taken to mitigate the stormwater impacts to the primary sludge tank replacement at the Post Point Resource Recovery Plant. This municipal owned wastewater treatment facility operates 24 hours per day and is critical to the City of Bellingham (City) infrastructure. The primary sludge tank functions as a component of the solids handling operation and has reached the end of its useful life.

The project includes demolition and replacement of the existing steel sludge tank located in the Solids Handling Building with a pair of new tanks to be located at the Project Site of the existing Chlorine Building. The Chlorine Building will be fully demolished as required by the design and replaced by the proposed tanks. The Chlorine Scrubber Building is to be repurposed with mechanical and electrical equipment to support the new sludge storage tank and associated odor control system. Some modified piping within the plant's pipe gallery and Solids Handling Building or in new trenches will likely be required for the Project, along with minor site improvements.

To provide external connectivity between the buildings and across the Project Site to other parts of the plant, concrete sidewalks will be installed, and some existing asphalt will be replaced. This stormwater report addresses the stormwater impacts of this hardscape.

Off-site stormwater flows from the adjacent properties will be unaffected by the development and will follow the existing drainage paths.

The project vertical datum for plans and calculations is NAVD88.

1.1 Project Location

The project is located within the Post Point Wastewater Treatment Facility at 200 McKenzie Ave, Bellingham, WA 98225.

1.2 Existing Conditions

The Post Point Wastewater Treatment Facility (Site) measures 33.03 acres, while the Project Site is defined as the limit of disturbance. This much more-localized area is 12,300 square feet (0.28 acres).

The Project Site includes the existing Scrubber Building and the Chlorine Building with its accompanying breezeway along with the concrete flatwork, landscaping, and asphalt driving surfaces that surround these buildings. The existing surfaces in this area are buildings, asphalt, concrete, and grass vegetation.

The Project Site drains from east to west through landscaped areas and is dispersed. Excess flows continue overland from east to west towards existing catch basins both along the curb line and in the asphalt to the west of the Project Site. The Project Site is generally flat with slopes of approximately 0.1% to 5.0%.

See Table 1-1 for the existing conditions of the project area.

TABLE 1-1 EXISTING PROJECT SITE AREA BREAKDOWN

Surface	Area (sf)
Building	2,246
Vehicular Asphalt & Concrete	3,161
Non-Vehicular Concrete & Flatwork	1,805
Landscape	5,098
TOTAL	12,310

See Appendix 'B' for Geotechnical Report.

1.3 Developed Conditions

All drainage design is in accordance with Section 15.42 of Bellingham Municipal Code and the 2019 Washington State Department of Ecology ***Stormwater Management Manual for Western Washington (Ecology Manual)*** and Bellingham Municipal Code Chapter 15.42 – Stormwater Management.

See Appendix 'E' for stormwater plans of the project. The project demolishes the existing Chlorine building and replaces it with sludge storage tanks (covered) and an odor control building. The existing scrubber building will remain. The breezeway will be demolished and will be replaced with asphalt surfacing. Sidewalk will be replaced, and some additional sidewalk will replace existing lawn areas. All areas within the Project Site that are not covered in hardscape will be reseeded with grass.

The stormwater system will include gutters, drain inlets, down spouts, and piping connections to the existing 12-inch storm drain main located under the unnamed treatment plant road to the west of the Project Site. The Project Site drains to the Post Point Lagoon

which then discharges into Bellingham Bay. Bellingham Bay is a flow control exempt water body and so the project is flow control exempt. The Project Site is also exempt from runoff treatment as the PGIS within the project are all considered "infrequently used maintenance access roads" (2019 SWMMWW). However, source Control Treatment BMPs will be provided to reduce any point source contaminants.

See Table 1-2 for the proposed condition of the total project area.

TABLE 1-2 PROPOSED CONDITION PROJECT SITE AREA BREAKDOWN

Surface	Proposed Area (sf)	Comparison to existing (sf)
Building	2,110	-134
Vehicular Asphalt & Concrete	3,200	+35
Non-Vehicular Concrete & Flatwork	2,300	+493
Landscape	4,700	-394
TOTAL	12,310	

See Table 1-3 for breakdown of the hard surfaces on the project .

TABLE 1-3 HARD SURFACES

Description	Existing (SF)	Removed (SF)	Proposed Replaced (SF)	Proposed New (SF)
Non-Pollution Generating (NPG) Hard Surface: Sidewalks, Paths, non-vehicular concrete, etc.	4,051	3,121	1939	359
Pollution Generating (PG) Hard Surface: Driveway, Parking, etc.	3,161	3,161	3,161	35
TOTAL HARD SURFACE	7,212	6,282	5,100	394

All runoff from this Project Site (PGIS and non-PGIS) will drain to street inlets and be discharged via existing stormwater pipes to the Post Point Lagoon and then into Bellingham Bay. This is identical to the existing condition.

See Appendix 'D' for Basin Map.

2.0 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A Temporary Erosion and Sediment Control Plan has been prepared, see Appendix 'C'. The plan outlines proposed measures for stormwater pollution control in detail.

The applicability of the 13 Elements from the Ecology Manual and BMC 15.42.060 are addressed below:

ELEMENT 1: MARK CLEARING LIMITS.

Prior to beginning land disturbing activities, including clearing and grading, all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area should be clearly marked, both in the field and on the plans, to prevent damage and offsite impacts. Plastic, metal, or stake wire fence may be used to mark the clearing limits. Retain the duff layer, native top soil, and natural vegetation in an undisturbed state to the maximum degree practicable.

ELEMENT 2: ESTABLISH CONSTRUCTION ACCESS.

a. Construction vehicle access and exit shall be limited to one route if possible.

b. Access points shall be stabilized with quarry spall or crushed rock to minimize the tracking of sediment onto public roads.

c. Wheel wash or tire baths should be located on-site.

d. Public roads shall at a minimum be cleaned thoroughly at the end of each day. Sediment shall be removed from roads by shoveling or pickup sweeping and shall be transported to a controlled sediment disposal area. Street washing will be allowed only after sediment is removed in this manner.

e. Street wash wastewater shall be controlled by pumping back on-site, or otherwise be prevented from discharging into systems tributary to state surface waters.

f. Control street wash wastewater by pumping back on site, or otherwise prevent it from discharging into systems tributary to waters of the state.

iii. ELEMENT 3: CONTROL FLOW RATES.

a. Properties and waterways downstream from the development site shall be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site.

b. Since the site is less than 3 acres, a sediment pond during construction is not required.

c. N/A – No retention / detention facilities are proposed.

d. N/A - No flow control facilities are proposed.

ELEMENT 4: INSTALL SEDIMENT CONTROLS.

a. Design, install, and maintain effective erosion controls and sediment controls to minimize the discharge of pollutants.

b. Construct sediment control BMPs (sediment ponds, traps, filters, etc.) as one of the first steps in grading. These BMPs shall be functional before other land-disturbing activities take place.

c. Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of resulting stormwater runoff, and soil characteristics, including the range of soil particle sizes expected to be present on the site.

d. Direct stormwater runoff from disturbed areas through a sediment pond or other appropriate sediment removal BMP, before the runoff leaves a construction site or before discharge to an infiltration facility. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard in subsection (F)(2)(e)(iii)(A) of this section.

e. Locate BMPs intended to trap sediment on site in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.

f. Where feasible, design outlet structures that withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column.

ELEMENT 5: STABILIZE SOILS.

a. All exposed and unworked soils shall be stabilized by application of effective BMPs that protect the soil from the erosive forces of raindrop impact and flowing water, and wind erosion. Applicable BMPs include, but are not limited to: temporary and permanent seeding, sodding, mulching, plastic covering, erosion control fabrics and matting, soil application of polyacrylamide (PAM), the early application of gravel base early on areas to be paved, and dust control.

b. Control stormwater volume and velocity within the site to minimize soil erosion.

c. Control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion.

d. From October 1st through April 30th of each year, no soils shall remain exposed and unworked for more than two days. From May 1st to September 30th of each year, no soils shall remain exposed and unworked for more than seven days. This condition applies to all soils on site, whether at final grade or not.

e. Stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast.

f. Minimize the amount of soil exposed during construction activity.

g. Minimize the disturbance of steep slopes.

h. Minimize soil compaction and, unless infeasible, preserve topsoil.

i. Applicable practices include, but are not limited to, temporary and permanent seeding, sodding, mulching, plastic covering, soil application of polyacrylamide (PAM), early application of gravel base on areas to be paved, and dust control.

j. Soil stabilization measures selected should be appropriate for the time of year, site conditions, estimated duration of use, and potential water quality impacts that stabilization agents may have on downstream waters or ground water.

k. Soil stockpiles must be stabilized and protected with sediment trapping measures and, where possible, locate away from storm drain inlets, waterways and drainage channels.

l. Work on linear construction sites and activities, including right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall not exceed the capability of the individual contractor for his portion of the project to install the bedding materials, roadbeds, structures, pipelines, and/or utilities, and to restabilize the disturbed soils, meeting the timing conditions listed above.

m. In addition, at the discretion of the public works director, those sites unable to maintain the quality of their stormwater discharge may be required to provide soil stabilization to all exposed soil areas regardless of the working status of the area. Upon written notification, the property owner shall provide full stabilization of all exposed soil areas within 24 hours.

ELEMENT 6: PROTECT SLOPES.

a. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion.

b. Consider soil type and its potential for erosion.

c. Reduce slope runoff velocities by reducing the continuous length of slope with terracing and diversions, reduce slope steepness, and roughen slope surface.

d. Divert upslope drainage and run-on waters from off-site with interceptors at top of slope. Off-site stormwater should be handled separately from stormwater generated on the site. Diversion of off-site stormwater around the site may be a viable option. Diverted flows shall be redirected to the natural drainage location at or before the property boundary.

e. Contain down slope collected flows in pipes, slope drains, or protected channels to prevent erosion. Temporary pipe slope drains must handle the peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year one-hour flow rate predicted by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model to predict flows, bare soil areas should be modeled as “landscaped area.”

f. Provide drainage to remove ground water intersecting the slope surface of exposed soil areas.

g. Excavated material shall be placed on the uphill side of trenches, consistent with safety and space considerations.

h. Check dams shall be placed at regular intervals within trenches that are cut down a slope.

i. Stabilize soils on slopes, as specified in Element #5.

ELEMENT 7: PROTECT DRAIN INLETS.

a. All nearby existing storm drain inlets and those made operable during construction shall be protected so that stormwater runoff shall not enter the conveyance system without first being filtered or treated to remove sediment.

b. All approach roads shall be kept clean, and all sediment and street wash water shall not be allowed to enter storm drains without prior and adequate treatment unless treatment is provided before the storm drain discharges to waters of the State.

ELEMENT 8: STABILIZE CHANNELS AND OUTLETS.

a. All temporary on-site conveyance channels shall be designed, constructed and stabilized to prevent erosion from expected peak flows. Channels must handle the peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis shall use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model to predict flows, bare soil areas should be modeled as “landscaped area.”

b. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes, and downstream reaches shall be provided at the outlets of all conveyance systems.

ELEMENT 9: CONTROL POLLUTANTS.

a. Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants.

b. All pollutants, including waste materials and demolition debris, that occur on-site during construction shall be handled and disposed of in a manner that does not cause contamination of stormwater.

c. Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the site (see Chapter 173-304 WAC, as currently enacted or hereafter modified, for the definition of inert waste, which is incorporated herein by this reference).

d. Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans, Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.

e. Wheel wash, or tire bath wastewater, shall be discharged to a separate on-site treatment system or to the sanitary sewer.

f. Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations shall be followed for application rates and procedures.

g. Management of pH-modifying sources shall prevent contamination of runoff and stormwater collected on the site. These sources include, but are not limited to, bulk cement, cement kiln dist, fly sash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, and concrete pumping and mixer washout waters.

h. Adjust the pH of stormwater if necessary to prevent violations of water quality standards.

i. Assure that washout of concrete trucks is performed off site or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Do not dump excess concrete on site, except in designated concrete washout areas. Concrete spillage or concrete discharge to surface waters of the state is prohibited. Do not wash out to formed areas awaiting infiltration BMPs.

j. Obtain written approval from Ecology before using chemical treatment other than CO_2, dry ice, or food grade vinegar to adjust ph.

k. Uncontaminated water from water-only based shaft drilling for construction of building, road, and bridge foundations may be infiltrated provided the wastewater is managed in a way that prohibits discharge to surface waters. Prior to infiltration, water from water-only based shaft drilling that comes into contact with curing concrete must be neutralized until pH is in the range of 6.5 to 8.5 (su).

ELEMENT 10: CONTROL DEWATERING.

a. All foundation, vault, and trench de-watering water, which has similar characteristics to stormwater runoff at the site, shall be discharged into a controlled conveyance system, prior to discharge to a sediment trap or sediment pond. Channels must be stabilized, as specified in Element #8.

b. Clean, non-turbid de-watering water, such as well-point ground water, can be discharged to systems tributary to state surface waters, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of the receiving waters. These clean waters should not be routed through sediment ponds with stormwater.

c. Highly turbid or otherwise contaminated dewatering water, such as from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam, shall be handled separately from stormwater at the site.

d. Other disposal options, depending on site constraints, may include, by way of example: (1) infiltration, (2) transport off site in vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters, (3) on-site treatment using Ecology approved chemical treatment or other suitable treatment technologies, (4) sanitary or combined sewer discharge with local sewer district approval, or if there is no other option, (5) use of a sedimentation bag that discharges to a ditch or swale for small volumes of localized dewatering.

ELEMENT 11: MAINTAIN BMPs.

a. All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with BMPs.

b. Sediment control BMPs shall be inspected weekly or after a runoff-producing storm event during the dry season and daily during the wet season. All projects that disturb an area greater than one acre shall have a certified erosion control lead available to the site. This erosion control lead shall be responsible to provide overview of ongoing day to day erosion control requirements. The erosion control lead shall (within 24 hours) report to the City and Department of Ecology any site discharges that exceed state water quality standards that have or are likely to have entered waters of the State.

c. All temporary erosion and sediment control BMPs shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal of BMPs or vegetation shall be permanently stabilized.

ELEMENT 12: MANAGE THE PROJECT.

a. Phasing of Construction – The development project shall be phased where feasible in order to prevent, to the maximum extent practicable, the transport of sediment from the development site during construction. Re-vegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.

b. When establishing these permitted clearing and grading areas, consideration should be given to minimizing removal of existing trees and minimizing disturbance/compaction of native soils except as needed for building purposes. Permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas, shall be delineated on the site plans and the development site.

c. Coordination with Utilities and Other Contractors - The primary project proponent shall evaluate, with input from utilities and other contractors, the stormwater management requirements for the entire project, including the utilities, when preparing the Construction SWPPP.

d. Inspection and Monitoring - All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function.

e. For any project disturbing more than one acre, a certified professional in erosion and sediment control shall be identified in the construction SWPPP and shall be on site or on call at all times. Certification may be through the Washington State Department of Transportation/Associated General Contractors (WSDOT/AGC) Construction Site Erosion and Sediment Control Certification Program or any equivalent local or national certification and/or training program, in the city's discretion.

f. Whenever inspection and/or monitoring reveals that the BMPs identified in the construction SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, the SWPPP shall be modified, as appropriate, in a timely manner.

g. Maintenance of the Construction SWPPP. The construction SWPPP shall be retained on site. The construction SWPPP shall be modified whenever there is a significant change in the design, construction, operation, or maintenance of any BMP.

ELEMENT 13: PROTECTION OF LOW IMPACT DEVELOPMENT BMP'S

a. Protect all bioretention and rain garden BMPs from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the bioretention and/or rain garden BMPs. Restore the BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden bioretention/rain garden soils, and replacing the removed soils with soils meeting the design specification.

b. Prevent compacting bioretention and rain garden BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.

c. Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements or base materials.

d. Pavement fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures in accordance with the Ecology Manual or the manufacturer's procedures.

e. Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils.

3.0 OFF-SITE ANALYSIS

3.1 Flow Control Discussion

The project runoff will be conveyed via pipes into the existing storm drain system within the Wastewater Treatment Plant, which is a piped system that outfalls into the Post Point Lagoon which then discharges into Bellingham Bay. As a saltwater body, Bellingham Bay is a Flow Control Exempt Receiving Water per the 2019 SWMMWW.

3.2 Off-Site Analysis

The runoff from the Project Site will be collected by three existing storm inlets, which are all connected to the storm main under the existing roadway to the west of the Project Site. (see Appendix 'D' for Basin Map).

The improvements result in a 394 sqft increase in impervious area. To quantify the increase in flows that this increase in impermeable area will generate, the rational method was used to quantify the flow rate from this 394 sqft area during the 25 year storm event. The resulting increase in runoff is 0.03 cfs. See Appendix 'F' for these calculations.

The smallest, flattest downhill pipe was identified using a combination of survey data, CityIQ, and reasonable assumptions. This pipe was a 12" diameter CCP pipe laid at 1.03% (COB asset ID: 0608412). Using Manning's Equation for open channel flow, this pipe has a capacity of 3.14 cfs when flowing full.

Relating the increase in flow to the flow capacity of the pipe when flowing mostly full (~3 cfs), the project will result in a 0.83% increase of flow of this pipe. See Appendix 'F' for hydraulic calculations.

Using this quantification, it was concluded that the increase in flows would be negligible to the downstream storm conveyance system and further analysis will not be required.

4.0 RUNOFF TREATMENT

Runoff from the project will flow directly into the Post Point Lagoon. Per the 2019 SWMMWW, this project is exempt from runoff treatment as the pollution generating surfaces qualify as infrequently used maintenance roads.

4.1 Infiltration Site Suitability

Per the Geotechnical report "Post Point Primary Sludge Tank Replacement by GeoEngineers, dated May 8th, 2024" (Appendix 'B'), infiltration is infeasible due to high groundwater levels and existing underground infrastructure.

5.0 SCHEDULE

The anticipated project schedule is as follows:

Project to Bid	February 2025
Construction Start	April 2025
Facilities in Service	Late 2025

6.0 CITY OF BELLINGHAM MINIMUM REQUIREMENTS

This project will require all nine of the City of Bellingham Storm Water Management Minimum Requirements. Each requirement is addressed as follows:

Minimum Requirement #1 – Stormwater Site Plan

See this report and the Civil plans.

Minimum Requirement #2 - Erosion and Sedimentation Control

All applicable sections of this requirement are described in Section 2.0 of this report and are addressed by the TESC plan.

Minimum Requirement #3 - Source Control of Pollution

The following Source Control BMP's are applicable to the project. Full details for each BMP can be found in the 2019 SWMMWW.

S410 BMP's for Correcting Illicit Discharges to Storm Drains
S453 BMP's for Formation of a Pollution Prevention Team
S454 BMP's for Preventive Maintenance / Good Housekeeping
S455 BMP's for Spill Prevention and Cleanup
S456 BMP's for Employee Training
S457 BMP's for Inspections
S458 BMP's for Record Keeping
S417 BMPs for Maintenance of Stormwater Drainage and Treatment Systems

Minimum Requirement #4 - Preservation of Natural Drainage Conditions

There are no natural drainage conditions on or near the project site.

Minimum Requirement #5 – Onsite Stormwater Management

The Project Site is Flow Control Exempt and so BMPs from List #3 for each surface type were analyzed for use on the project.

For lawn and landscaped areas, BMP T5.13 (Post-Construction Soil Quality and Depth) will be used, per the landscape plans.

For the roof drainage flows, BMP T5.10A (Downspout Full Infiltration), BMP T5.10B (Downspout Dispersion Systems) and BMP T5.10C (Perforated Stub-out Connections) are infeasable due to high groundwater levels and existing underground infrastructure, and lack of sufficient vegetated flow paths. See Appendix 'B' for the geotechnical report for additional details.

For the other hard surfaces, BMP T5.12 (Sheet Flow Dispersion) and BMP T5.11 (Concentrated Flow Dispersion) are also infeasiable due to lack of sufficient vegetated flow paths.

Minimum Requirement #6 - Runoff Treatment

Per the 2019 SWMMWW, this project is exempt from runoff treatment as it qualifies as an infrequently used maintenance road.

Minimum Requirement #7 - Flow Control

The Project Site is flow control exempt as the stormwater systems discharges via man-made conveyance to Bellingham Bay.

Minimum Requirement #8 – Wetlands Protection

There are no wetlands within the project limits.

Minimum Requirement #9 – Operation and Maintenance

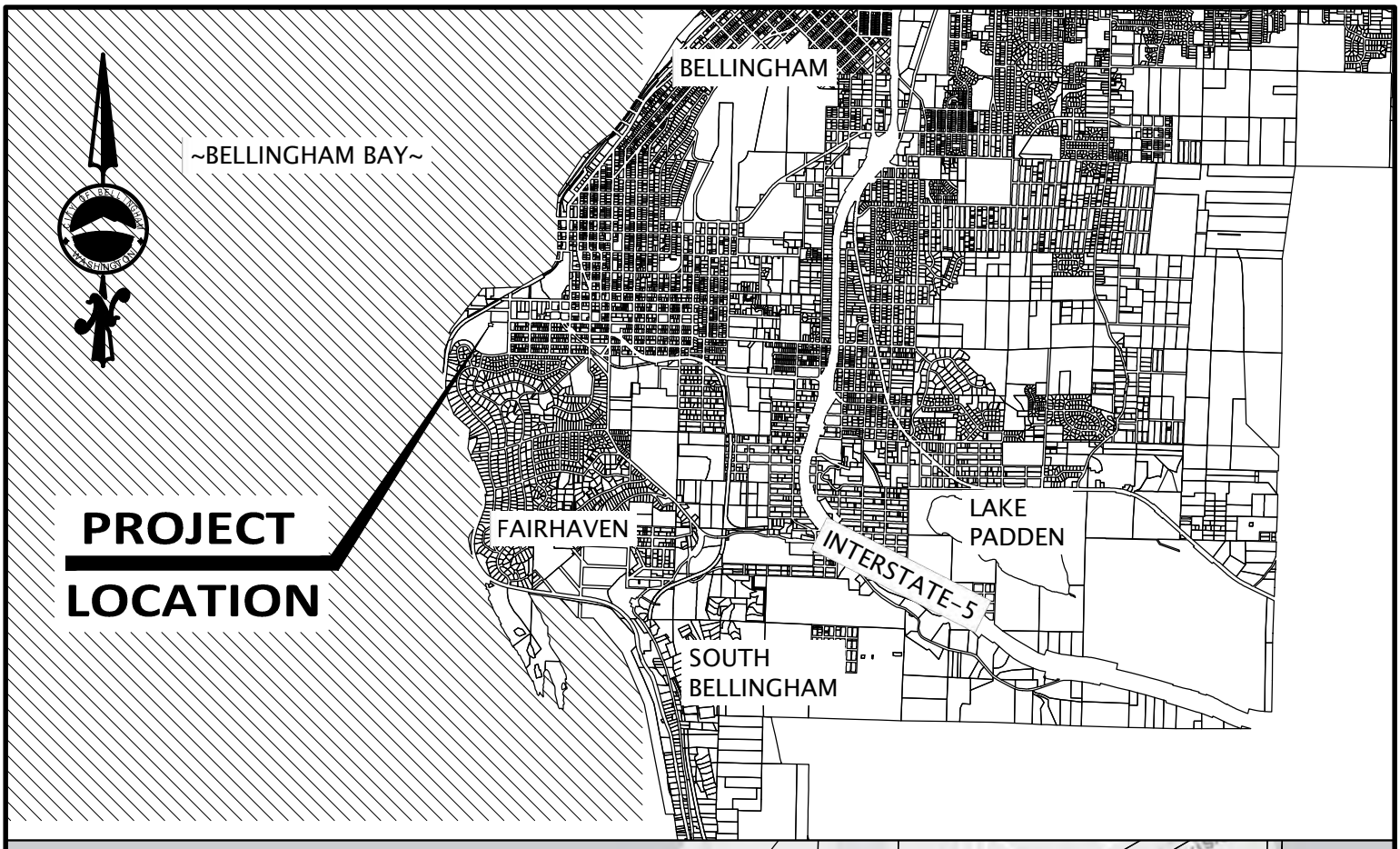
Operation and maintenance of temporary facilities will be by the Contractor during construction. The permanent stormwater facilities which require operation and

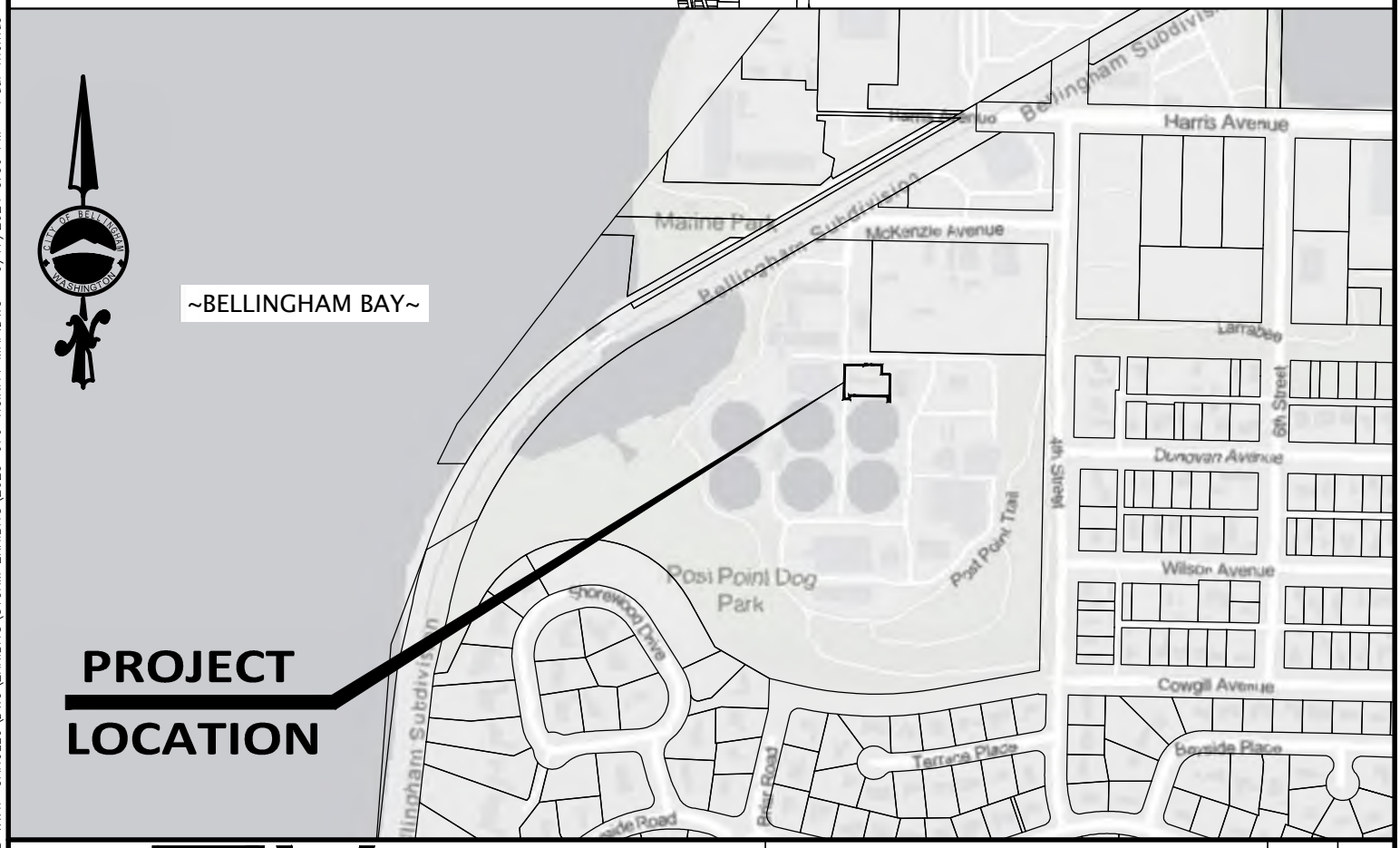
maintenance are the collection components (gutters, inlets and manholes) and the conveyance elements (storm pipes). Per the City of Bellingham's Surface and Stormwater Comprehensive Plan dated September 21, 2020, the City must inspect all catch basin structures once every 2 years, or within an alternative schedule compliant with its Phase II Permit requirements.

7.0 FEMA FLOOD ZONE

No areas of the project are located within the FEMA 100 year flood plain. See Appendix 'H' for the FEMA flood zone map.

APPENDIX A – Vicinity Map





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APPENDIX A- VICINITY MAP
NOT TO SCALE

BELLINGHAM WASHINGTON

PRIMARY SLUDGE REPLACEMENT PROJECT
POST POINT, WASTEWATER TREATMENT PLANT

DATE	SHEET
9/17/2024	1
SCALE N/A	OF 1
JOB NO. 2023-070	

PLOT SETTINGS: DWG To PDF.pc3, ANSI full bleed A (8.50 x 11.00 Inches), Portrait, 1:1, WE APWA_UNSCREENED.ctb
W:\2023\2023-070 COB WWTP CAROLLO\DWG\EXHIBITS\STORM EXHIBITS\2023-070 VICINITY MAP.DWG - 9/17/2024 3:30 PM - Paul Thomas

APPENDIX B – Geotechnical Report

Geotechnical Design Services

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

for
Carollo Engineers

May 8, 2024

DRAFT

554 West Bakerview Road
Bellingham, Washington 98226
360.647.1510

GeoEngineers

Geotechnical Design Services

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

File No. 0356-185-00
May 8, 2024

Prepared for:

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1.0 Introduction and Scope of Services

This design report presents the results of our geotechnical engineering services for the evaluation of subsurface soil and ground water conditions for the planned Post Point Primary Sludge Tank Replacement project at the Post Point Wastewater Treatment Plant (WWTP) in Bellingham, Washington. The generalized location of the WWTP site is shown in the Vicinity Map, Figure 1.

The purpose of our services was to review existing information and explore subsurface soil and groundwater conditions at the locations of proposed site improvements as a basis to provide geotechnical engineering recommendations for design. Our scope of services included:

- Research and review of available geotechnical information;
- Completing geotechnical explorations including two geotechnical borings;
- Completing laboratory testing on samples obtained from the borings;
- Performing engineering analyses and providing geotechnical conclusions and recommendations for design and construction of the proposed sludge tank replacement; and
- Preparing this geotechnical engineering report.

Our specific scope of services is described in Task Order No. 1 Signed Agreement between Carollo and GeoEngineers, Inc. (GeoEngineers), effective date, July 12, 2023.

2.0 Project Description

We understand that the original design for the WWTP was completed in 1971 with expansions that occurred in 1989 and 2010. Our understanding of this proposed expansion project is based on information provided by Carollo Engineers. The Site and Exploration Plan, Figure 2 attached, shows the proposed locations of the structures identified for these improvements.

As currently envisioned, we understand the City intends to replace the existing steel sludge tank located in the nearby Solids Handling Building 510 with a pair of new 50,000-gallon tanks to be located at the site of the existing Chlorine Building. The weight of the sludge to be held within the tanks is expected to be approximately 440 kips in each tank, for a total of 880 kips. The estimated weight of the concrete structure is 2,100 kips. The existing at-grade Chlorine Building will be demolished, and the new tanks will be exterior (i.e., not housed within a building). The foundations are anticipated to extend 11.5 feet below grade (Elevation 6.5 feet, NAVD 88). Some modified piping within the existing pipe gallery or in new trenches will likely be required for the project, along with other appurtenant site improvements. Adjacent to the new Sludge Tanks will be an Odor Control Facility with a weight of 14 kips, which is planned to be supported by a new slab-on-grade. The existing Scrubber Building 420 has a basement level that extends 9.5 feet below grade and will remain and house additional process improvements but will be structurally modified as necessary per American Society of Civil Engineers (ASCE) 41-17.

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3.0 Site Background and Research

The site of the existing Post Point WWTP and proposed Sludge Tank Replacement is an area of historic ground modification, including excavation of peat and organic soils and backfill with structural fill, and some excavation of granular borrow soils in select areas of the site. In addition to local geologic maps, we have reviewed available subsurface information from the previous phases of site development, including the following sources:

- CH2M Hill, "Post Point Wastewater Treatment Plant Upgrade Geotechnical Design Report," September 1971.
- CH2M Hill, "Post Point Wastewater Treatment Plant Upgrade Geotechnical Data Report," September 1989.
- CH2M Hill, "Post Point Wastewater Treatment Plant Upgrade, Initial Design Review Submittal – Design Guidelines," September 1989.
- GeoEngineers, "Post Point Wastewater Treatment Plant Improvements Geotechnical Engineering Report," October 6, 2010.
- GeoEngineers, "Post Point Wastewater Treatment Plant Biosolids Geotechnical Pre-Design Report," February 14, 2022.

4.0 Site Conditions

4.1 SURFACE CONDITIONS

The project site is in the Fairhaven area of south Bellingham, southwest of the intersection of McKenzie Avenue and 4th Street. The site is bounded by Bellingham Bay, an intertidal lagoon, and Burlington Northern Santa Fe (BNSF) railroad tracks and embankment to the west and northwest. An industrial/transportation district is located to the north and northeast. A residential neighborhood is located to the southeast, south, and southwest, primarily on the raised bluffs above the site.

The proposed sludge tank replacement site is located at the southeast corner of two unnamed plant access roads with generally level topography. Steeper slopes are present on the margins of the WWTP toward the south and east. The site is generally covered with asphalt, concrete sidewalks, existing buildings, or manicured lawn. There are numerous underground utilities including utility vaults and tunnels.

4.2 GEOLOGIC SETTING

We reviewed various geologic maps for the project area (Easterbrook 1976, Lapen 2000, and Department of Ecology 1977). The maps indicate that the site is underlain by the Chuckanut Formation bedrock, Fraser drift glacial deposits, alluvium/beach deposits, and artificial fill.

The Chuckanut Formation consists of sandstone, conglomerate, shale, and coal deposits. The bedrock typically encountered in the project vicinity consists of sandstone or siltstone. Bedrock was mapped at/near the ground surface in both the Easterbrook and Lapen maps, although no surface exposures of bedrock are present in the immediate project vicinity, and bedrock was not encountered in the recent site explorations.

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The Washington State Department of Ecology (Ecology) Costal Zone Atlas maps soils in the project vicinity as Fraser drift, an undifferentiated glacial deposit composed of various glacial sources including glacial outwash, terrace deposits, glaciomarine drift, and glacial till. The soil types in this unit will depend on the depositional environment.

One predominant soil unit within the Fraser drift is a glaciomarine deposit locally referred to as Bellingham (glaciomarine) Drift. This glaciomarine deposit consists of unsorted, unstratified silt and clay with varying amounts of sand, gravel, cobbles, and occasional boulders. Glaciomarine drift is derived from sediment melted out of floating glacial ice that was deposited on the sea floor. Glaciomarine drift was deposited during the Everson Interstade approximately 11,000 to 12,000 years ago while the land surface was depressed 500 to 600 feet from previous glaciations. This unit is predominantly medium stiff to soft and possesses relatively low shear strength and moderate to high compressibility characteristics in a lowland environment. Glacial till, a subset of the Fraser drift, is typically dense as a result of being overridden by glaciers, with resultant high shear strength and low compressibility characteristics.

Alluvium typically consists of sand, gravel, and silt with areas of clayey and organic soil, deposited on beaches, spits, and modern flood plains, and may include some nearshore inter-tidal deposits. Based on the site location we have interpreted these deposits at the site to be representative of beach deposits.

The artificial fill identified at the site is the result of historical ground modification. The WWTP has been located at the site since 1971. During previous site development, some of the peat has been removed and fill has been brought into the site to raise grades to present elevations. The project area is located within the historical peat removal area.

4.3 GEOLOGICALLY HAZARDOUS AREAS

Geologically hazardous areas are designated by the City of Bellingham Critical Areas Ordinance (CAO) per Bellingham Municipal Code 16.55.410 – 16.55.460. In addition to the definition of the geologically hazardous areas in the CAO, the City has developed a folio of maps that identify these areas in their database. In general, the CAO requires that a qualified professional assess the geologic hazards based on review of available information and field studies, evaluate the specific project proposal with respect to relationship and impact on the hazard area and adjacent sites if appropriate, provide minimum buffers and setbacks, and provide mitigation strategies where appropriate for specific geologic hazards. The geologically hazardous areas include erosion, landslide, seismic, and mines. Additional potential geologic hazards which are not part of the code at this time are sea level rise and tsunami hazards.

4.3.1 Erosion Hazard Areas

Erosion hazard areas are defined by the CAO as areas prone to soil erosion including:

- Any area where soil type is predominantly sand, clay, silt, and/or organic matter and slopes greater than 30 percent.

The site area slopes less than 30 degrees and does not meet the CAO definition for an erosion hazard area. This hazard type can be mitigated with conventional construction practices as discussed later in this report.

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4.3.2 Landslide Hazard Areas

Landslide hazard areas are defined by the CAO as those susceptible to landslides and/or subsidence that could include movement of soil, fill materials, rock, or other geologic strata. Specific landslide designations as defined by the CAO include:

- Slopes equal to or greater than 40 percent grade (2.5H:1V [horizontal to vertical] or 22 degrees) with an elevation change of at least 10 feet.

The CAO mapping does not indicate that a landslide hazard is present at the project location. The site does not currently have slopes greater than 40 percent grade with at least 10 feet of vertical relief that will be modified during construction. In our opinion, the site does not meet the definition of a Landslide Hazard Area and this hazard type is not addressed further in this report.

4.3.3 Seismic Hazard Areas

Seismic hazard areas are defined by the CAO as those areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface rupture. Specific areas of very high response to seismic shaking include:

- Areas depicted as “fill” and “alluvial deposits” on geologic maps.
- Areas mapped as high response to seismic shaking.

Some of the soils encountered in our explorations exhibit a moderate to high potential response to seismic shaking. The site is located near the shoreline in an area of modified land overlying a soft soil profile, and therefore is a recognized seismic hazard area. Accordingly, potential impacts and mitigation strategies have been identified and are discussed in the subsequent sections of this report.

4.3.4 Mine Hazard Areas

Mine hazard areas are defined by the CAO as those areas underlain by or affected by historical mine workings. Specific hazard areas include:

- Areas depicted within Geologic Hazards Map , Bellingham, Washington, February 2, 2022.

The project site is located approximately 1,600 feet west of the Union Mine portal location based on the Map Folio. No known mine workings are mapped at the project site. Accordingly, the area does not meet the definition of a mine hazard area and mine hazards will not be addressed further in this report.

4.3.5 Tsunami Hazard and Sea Level Rise

Tsunami hazard and impacts of sea level rise are not specifically defined in the CAO; however, because of the proximity to the shoreline, we evaluated if these potential hazards are present at the site. The site is located in an area that is not a mapped tsunami inundation zone (DNR 2004). Therefore, no mitigation is required.

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4.4 SUBSURFACE CONDITIONS

4.4.1 Subsurface Exploration

The subsurface explorations completed by GeoEngineers for this project consisted of two geotechnical borings. Borings B-1-23 and B-2-23 were completed on July 27, 2023, using a hollow stem auger and were advanced to depths of 16½ and 61½ feet below existing ground surface (bgs). The drilled explorations were subcontracted to GeoEngineers. The approximate locations of the explorations are shown in Figure 2. Details of the field exploration program, laboratory testing, and the exploration logs are presented in Appendix A.

4.4.2 Soil Conditions

Subsurface soils encountered were classified as fill, beach deposits, glaciomarine/undifferentiated glacial drift, and glacially consolidated soils. A description of each geologic unit is presented below.

FILL. Fill of variable soil types and density/consistency was encountered in both explorations. The fill thickness ranged from 15 to 16½ feet bgs. Fill consisted of loose to medium dense sand with variable gravel and silt/clay content and is interpreted to have been placed following historical peat removal in this area. Some scattered organic material, shells, and iron-staining were also encountered in the fill soils. Boring B-1-23 terminated in this unit.

BEACH DEPOSITS. Beach deposits were encountered underlying fill in boring B-2-23. This unit was observed from depths of approximately 15 to 20 feet bgs. The beach deposits generally consisted of loose silty sand with shell fragments.

GLACIOMARINE/GLACIAL DRIFT. Glacial deposits interpreted to be a glaciomarine drift unit were encountered underlying beach deposits in boring B-2-23. The glaciomarine drift encountered generally consists of soft to very stiff clay, grading to silty clay with variable sand content. The glaciomarine drift was observed from approximately 20 to 50 feet bgs.

GLACIALLY CONSOLIDATED SOILS. Glacially consolidated soils, distinguished from the glaciomarine drift because of its relatively higher density and lower moisture content, was encountered in boring B-2-23 underlying glaciomarine drift at a depth of approximately 50 feet bgs. The glacially consolidated soil encountered was typically dense to very dense silty sand, medium to coarse sand with silt, and gravel with sand and silt. Exploration B-2-23 terminated in this unit.

4.4.3 Groundwater Conditions

Groundwater was observed at the time of drilling at approximately 25 feet bgs in exploration B-2-23 and was not observed in exploration B-1. We reviewed environmental groundwater monitoring information from Whatcom Environmental for MW-3 that indicates the groundwater elevation is approximately 13 feet. Groundwater levels should be expected to fluctuate in response to rainfall, seasonal variations, possibly tidal variations, and other factors.

5.0 Conclusions and Recommendations

Based on our evaluation, design and construction of the sludge tank is feasible; however, the site conditions include fill, naturally occurring compressible soils, and liquefiable soils at variable depths which must be

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carefully considered to achieve desirable foundation performance. A relatively shallow groundwater table is present that affects both design and construction of below-grade structures. The following report sections provide geotechnical considerations for the proposed replacement Sludge Tanks at the location of the existing Chlorine Building that includes pile support to mitigate liquefaction and settlement. Additionally, seismic parameters are provided for the retrofit of the existing Scrubber Building 420.

5.1 GEOLOGIC HAZARDS AND MITIGATION

The following sections discuss recommended mitigation strategies for geologically hazardous areas identified in Section 4.3 above.

5.1.1 Erosion Hazard Considerations

The area of the proposed construction includes a relatively level area of historically placed fill. As currently envisioned, earthwork construction for the sludge tank foundation will require excavations on the order of 5 to 7 feet bgs. Although the site does not meet the CAO definition of an erosion hazard area, the primary erosion hazard at the site is from temporary conditions created during construction.

In our opinion, provided typical erosion and sedimentation controls are implemented during construction, the site does not present a significant erosion hazard. Stormwater should be prevented from flowing across disturbed areas and not directed toward the slopes during construction. Temporary erosion control measures should be used during construction depending on the weather, location, soil/rock type, and other factors. Temporary erosion protection (e.g., straw, plastic, or rolled erosion control products [RECPs]) may be necessary to reduce sediment transport until vegetation is established or permanent surfacing applied.

Appropriate best management practices (BMPs) should be incorporated into the temporary erosion and sediment control plan by the civil engineer. All finished slopes should be protected and/or vegetated before the rainy season. Provided that proper grading practices are used and BMPs incorporated into the grading plans, we conclude that the erosion hazard will be adequately mitigated during site development. During construction, the contractor would be subject to Ecology regulations which require performance-based testing of turbidity at all discharge points. Proper construction practices and monitoring procedures will manage the risks to the standard of practice.

5.1.2 Seismic Hazard Considerations and Design

5.1.2.1 SITE SEISMICITY

The site is located within the Puget Sound region, which is seismically active. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca, and North American plates. The Juan de Fuca plate is subducting beneath the North American plate. It is thought that the resulting deformation and breakup of the Juan de Fuca plate might account for the deep focus earthquakes in the region. Hundreds of earthquakes have been recorded in the Puget Sound area. In recent history, four of these earthquakes were large events: (1) in 1946, a moment magnitude (Mw) 7.5 earthquake occurred in the Vancouver Island, British Columbia area; (2) in 1949, a Mw 6.7 earthquake occurred in the Olympia area; (3) in 1965, a Mw 6.6 earthquake occurred between Seattle and Tacoma; and (4) the 2001, Mw 6.8 Nisqually earthquake.

Research has concluded that historical large magnitude subduction-related earthquake activity has occurred along the Washington and Oregon coasts. Evidence suggests several large magnitude

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earthquakes (Mw 8 to 9) have occurred in the last 1,500 years, the most recent of which occurred about 300 years ago. No earthquakes of this magnitude have been documented during the recorded history of the Pacific Northwest. Local design practice in Puget Sound and local building codes consider these seismic conditions, including known faults for the design of structures.

5.1.2.2 2021 INTERNATIONAL BUILDING CODE (IBC) SEISMIC DESIGN INFORMATION

We understand that the project components for the tanks will be designed utilizing the 2021 International Building Code (IBC). The 2021 IBC references the 2016 version of Minimum Design Loads for Buildings and Other Structures (ASCE 7-16) for the Site Class determination and the development of seismic design parameters.

Per ASCE 7-16 Section 20.3.1, the site is classified as Site Class F due to the presence of potentially liquefiable soils (discussed below). Site-response analysis is required for Site Class F sites per Section 11.4.8; however, Section 20.3.1 provides an exception for structures that have fundamental periods of vibration less than 0.5 sec, whereby the site class may be determined in accordance with Section 20.3 (i.e., the underlying site class not considering liquefaction) and the corresponding site coefficients determined based on mapped seismic parameters in Section 11.4.4. We anticipate that the proposed structure has a fundamental period of vibration that is less than 0.5 sec; therefore, the exception in Section 20.3.1 applies. This assumption should be confirmed by the structural engineer.

Based on the subsurface data from our borings, the weighted average of the blow counts in the top 100 feet was estimated, which is used as a parameter to estimate the seismic site class of the site, as per ASCE 7-16. The underlying site is best classified as Site Class D – Stiff Soil Profile. Per ASCE 7-16 Section 11.4.8 a ground motion hazard analysis is required for structures on Site Class D with S_1 greater than or equal to 0.2 g (where g represents gravitational acceleration). The mapped S_1 value for this site is 0.358 g. Exception 2 in Section 11.4.8 allows the structural designer to use ground motions based on the site class and mapped spectral acceleration rather than completing a site-specific response analysis. Where the value of 'T' in this exception represents the fundamental period of the structure, T_S=0.62 sec, and T_L=16 sec.

The design parameters for the 2021 IBC are summarized in Table 1. These values are based on an earthquake event that has a 2 percent chance of exceedance in a 50-year period (2,475-year return period).

If requested, we can complete a site-specific seismic response analysis or a ground motion hazard analysis. These analyses could provide reduced seismic demands relative to the parameters in Table 1 and the requirements of ASCE 7-16 Section 11.4.8 Exception 2 depending on the structure configuration and site-specific subsurface conditions.

TABLE 1. MAPPED 2021 IBC SEISMIC DESIGN PARAMETERS

SEISMIC DESIGN PARAMETERS	RECOMMENDED VALUE[1,2]
Site Class	D[3, 4]
Mapped Spectral Response Acceleration at Short Period (S_S)	1.018 g
Mapped Spectral Response Acceleration at 1 Second Period (S_1)	0.358 g
Site Modified Peak Ground Acceleration (PGA_M)	0.507 g

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Site Amplification Factor at 0.2 second period (F_a)	1.093
Site Amplification Factor at 1.0 second period (F_v)	1.942
Design Spectral Acceleration at 0.2 second period (S_{DS})	0.742 g
Design Spectral Acceleration at 1.0 second period (S_{D1})	0.463 g
S_{D1}/S_{DS} (T_S)	0.62 seconds

Notes:

[1] Parameters developed based on Latitude 48.718156° and Longitude -122.51382° using the online ASCE 7 Hazard Tool.

[2] These values are only valid if the structural engineer utilizes Exception 2 of Section 11.4.8 (ASCE 7-16).

[3] The site may be classified as Site Class D if the exception applies in Section 20.3.1 (ASCE 7-16).

[4] Soil Profile Type D Description: Stiff Soil Profile (15 ≤ N ≤ 50).

5.1.2.3 2017 ASCE 41-17 SEISMIC DESIGN INFORMATION

Seismic design of the proposed improvements for the Scrubber Building will be completed using procedures outlined in ASCE 41-17 (2017). We understand the existing structures will be evaluated based on both the Basic Safety Earthquake-1 Event (BSE-1E) and Basic Safety Earthquake-2 Event (BSE-2E). The desired performance objectives are taken as a seismic hazard with a 20 percent probability of exceedance in 50 years (225-year return period) and with a 5 percent probability of exceedance in 50 years (975-year return period), for the two events respectively. The site is classified as Site Class F per ASCE 7-16 (2016) Chapter 20 due to the presence of potentially liquefiable soils at the site (discussed later). In the absence of the potential for liquefaction triggering, the site would otherwise be classified as Site Class D based on blow count data collected during site exploration.

ASCE 41-17 does not provide seismic parameters for Site Class F sites and requires site-specific ground motion procedure to determine if the short-period spectral response acceleration (S_S) value is greater than or equal to 0.2 g. We understand that the building period meets the ASCE 41-17 exception for structures below periods of 0.5 seconds, in which case the parameters provided for Site Class D below are appropriate.

Recommended seismic design parameters for code level seismic design in accordance with ASCE 41-17 (and ASCE 7-16) are presented in Table 2 below and consider Risk Category IV and Site Class D.

TABLE 2. ASCE 41-17 SEISMIC PARAMETERS

ASCE 41-17 PARAMETER	BSE-1E RECOMMENDED VALUE[1]	BSE-2E RECOMMENDED VALUE[1]
Site Class	D[2]	D[2]
Short-period Spectral Response Acceleration, S_S	0.36 g	0.76 g
1-second Period Spectral Response Acceleration, S_1	0.115 g	0.265 g
Short-period Site Coefficient, F_a	1.512	1.196
Long-period Site Coefficient, F_V	2.37	2.07
Site Class Adjusted Short-period Spectral Response Acceleration, S_{XS}	0.544 g	0.909 g
Site Class Adjusted 1-second Spectral Response Acceleration, S_{X1}	0.272 g	0.549 g

Notes:

[1] Parameters developed based on Latitude 48.718156° and Longitude -122.51382° online ASCE 7 Hazard Tool.

[2] Parameters are provided for Site Class D.

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5.1.2.4 LIQUEFACTION POTENTIAL

Liquefaction is a phenomenon where soils experience a rapid loss of internal strength as a consequence of strong ground shaking. Loss of bearing support, ground settlement, lateral spreading, and/or sand boils may result from liquefaction. Conditions favorable to liquefaction occur in very loose to medium dense, clean to moderately silty sand that is below the groundwater level. Dense soils or soils that exhibit cohesion are less likely to be susceptible to liquefaction. Soils considered susceptible to liquefaction underlying the project site include a limited thickness of granular beach deposits.

The evaluation of liquefaction potential is complex and is dependent on numerous site parameters, including soil grain size, soil density, site geometry, static stresses, and the magnitude and ground acceleration of the design-level earthquake. Typically, the liquefaction potential of a site is evaluated by comparing the cyclic shear stress ratio (the ratio of the cyclic shear stress to the initial effective overburden stress) induced by an earthquake to the cyclic shear stress ratio required to cause liquefaction.

We evaluated the liquefaction potential of the saturated soils underlying the site following the methods of Youd and Idriss (2001) and estimated settlement based on two methods (Tokimatsu and Seed 1987; Ishihara and Yoshimine 1992) based on the Standard Penetration Test (SPT) data from our drilled borings. For this site, the design-level earthquake consists of a moment magnitude of 6.97 and a peak horizontal ground acceleration of 0.507 g. The design earthquake parameters were developed using published hazard maps associated with an earthquake event that has a 2 percent chance of exceedance in a 50-year period (2,475-year event) as required by IBC.

Groundwater was assumed to be encountered at a depth of about 5 feet bgs. The results of our analyses indicate that saturated portions of the loose to medium dense native beach deposits have a moderate potential for liquefaction during a design earthquake event. Our analyses indicate that settlement caused by liquefaction of the saturated portions during a design earthquake could be on the order of 1½ to 3 inches. The variability of site conditions suggests that liquefaction and subsequent settlement will be sporadic across the site and differential settlement over short distances could equal the total anticipated liquefaction settlement. Pile foundations discussed subsequently in this report may effectively mitigate liquefaction induced settlement.

5.1.2.5 LATERAL SPREADING

In addition to settlement, there is the possibility that lateral spreading of the soils could occur as a result of soil liquefaction. Lateral spreading involves lateral displacement of large, surficial blocks of non-liquefied soil, as well as the liquefied soil itself, as the underlying soil layer liquefies. Lateral spreading generally develops in areas where sloping ground is present or near a free face, such as a river or slough. If liquefaction were to occur within the granular layers at the site, we anticipate that, because of the sporadic nature of the liquefiable soils, there would be a relatively low potential for lateral spreading to occur at the site. During a design earthquake, lateral spreading displacements, characterized by movement of the soils towards Bellingham Bay, are estimated to be on the order of 1 to 2 inches for a 2,475 year earthquake, with perhaps little to no lateral spreading occurring for lower levels of ground shaking. The lateral displacement is likely further mitigated by other structures between the proposed Sludge Tank and Bellingham Bay.

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5.1.2.6 SURFACE FAULT RUPTURE

The nearest active faults include the Birch Bay fault, located approximately 7 miles northwest of the site, and the Sandy Point fault, located approximately 8 miles north of the site. These faults are not capable of producing a Mw 7.0 seismic event based on the United States Geologic Survey (USGS) deaggregation tool. Per ASCE 7-16 Section 11.4.1, the site is not considered a near-fault site, and therefore, the risk of surface rupture at the site is interpreted to be low.

5.2 EXISTING SCRUBBER BUILDING CONSIDERATIONS

The existing Scrubber Building will be modified and repurposed as the Sludge Storage Building. The existing building has a basement constructed with a mat foundation and concrete walls. The bottom of the foundation is approximately 11 feet below the ground level. The existing building is bearing on soil layers consisting of loose to medium-dense native beach deposits and granular portions of the glacial drift, which has a moderate potential for liquefaction during a design earthquake event. Liquefaction could result in vertical settlement of 1½ to 3 inches and differential settlement of 1 to 2 inches over the width of the structure, which are considered to be within acceptable limit for mat-type foundation. The basement can be considered a rigid foundation for the building and perform during a liquefaction event under design earthquake level. New utility lines (such as pipes, ducts, conduits, ductbanks, etc.) to the structure should be provided with flexible joints to accommodate the potential liquefaction settlement

5.3 SETTLEMENT CONSIDERATIONS

The combined short and long-term settlement estimates for this project are 2¾ inches which exceed the tolerable total vertical displacement of 1 inch if the foundation loads for the new replacement Sludge Tank were supported by the liquefiable beach deposits and soft to stiff clay that is located below the proposed foundation elevation. As settlement mitigation, we recommend that the Sludge Tanks be supported by piles as discussed below. Various ground improvement and pile support options were considered. However, based on the nearby utility tunnel and other nearby existing infrastructure, including the basement in the adjacent Scrubber Building 420, methods that include intense vibration such as driven piles or vibroreplacement aggregate piers were not considered feasible. Recommendations for drilled augercast piles are provided in the following sections.

5.4 PILE FOUNDATION RECOMMENDATIONS

Pile foundations are an option to provide foundation support and reduce anticipated total and differential settlements within tolerable levels and avoid liquefaction induced subsidence to the structures. As currently envisioned, augercast piles are the preferred pile type to support the proposed Sludge Tanks because of the relatively deep soft soil profile under the proposed structure and heavy loads applied that are not compensated with foundation excavation.

5.4.1 Augercast Piles

Augercast piles are the preferred pile type because they are a relatively economical type of deep foundation, there is minimal disturbance of adjacent structures during installation, the equipment provides a cased hole for installation of the pile, and because there is a lower level of construction noise (i.e. no pile driving) with lesser impacts to adjacent wildlife habitat. Drilled shafts would require temporary casings because of the soft soils. Other pile types, such as driven steel pipe or H-piles, are also feasible, but with greater noise impacts. Recommended capacities for these pile types can be provided if requested.

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Augercast piles are constructed using a continuous flight hollow stem auger attached to a set of leads supported by a crane. The first step in the pile casting process consists of drilling the auger into the ground to the specified tip elevation of the pile. Grout is then pumped through the hollow stem auger upon steady withdrawal of the auger and replaces the soils removed on the flights of the auger. The final step is to install a steel reinforcing cage and typically a center bar into the column of fresh grout. The benefit of using augercast piles in this environment is that the auger provides support for the soils during the pile installation process, thus eliminating the need for temporary casing or drilling fluid. Augercast piles were successfully used for support of the new Secondary Clarifier and Activated Sludge Basin in 2012.

5.4.2 Vertical Axial Capacities

We have estimated the vertical axial load capacities of 18-inch and 24-inch diameter augercast piles. Axial pile capacity in compression will be developed from a combination of frictional resistance in the medium stiff to stiff clayey glacial drift soils underlying the site, and end bearing in the dense glacially consolidated soils. The surface of the glacially consolidated soil should be anticipated to vary and will derive most of their support from end bearing in this unit. Uplift pile capacity at both locations will be developed from frictional resistance in the glacial drift and glacially consolidated soils.

Allowable pile capacities are provided for Allowable Stress Design (ASD). The allowable capacities are for combined dead plus long term live loads and may be increased by one-third when considering design loads of short duration such as seismic forces. The allowable capacities are based on the strength of the supporting soils for the depths below the existing ground surface and include a factor of safety of about 3 for end bearing and 2 for shaft friction. The capacities apply to single piles. If piles are spaced at least three pile diameters on center as recommended, no reduction for group action is needed. The values provided below include a reduction in axial capacity resulting from downdrag of existing fill soils overlying the liquefiable beach deposits.

The structural characteristics of pile materials and structural connections may impose limitations on pile capacities and should be evaluated by the structural engineer. For example, steel reinforcing will be needed for augercast piles subjected to uplift or large bending moments.

Table 3 below presents a summary of the allowable axial pile capacity (compression and uplift) for the proposed pile locations. To achieve suitable bearing at these locations, we recommend a minimum embedment of about 5 feet into the dense glacial till. Based on our subsurface explorations, pile lengths on the order of 43 to 53 feet bgs are anticipated to achieve the desired embedment. We anticipate that the glacially consolidated soil layer will be encountered at shallower depths toward the eastern end of the proposed building footprint.

TABLE 3. AXIAL PILE CAPACITIES –SLUDGE TANKS

EMBEDMENT DEPTH IN GLACIAL TILL (FEET)	ALLOWABLE PILE CAPACITY (KIPS)			
	18-INCH AUGERCAST PILE		24-INCH AUGERCAST PILE	
	COMPRESSION	UPLIFT	COMPRESSION	UPLIFT
5	170	60	270	80

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5.4.3 Lateral Capacities

Lateral loads can be resisted by the skin friction and passive soil pressure on the vertical piles and by the passive soil pressures on pile caps. Because of the potential separation between the pile-supported foundation components and the underlying soil from settlement, base friction on pile caps should not be included in calculations for lateral capacity.

We analyzed the ultimate lateral load capacity of 18-inch and 24-inch augercast piles with the pile head fixed against rotation. The soil profile for lateral pile evaluation was completed for two cases. For the Sludge Tanks the top of pile was assumed to be at a depth of at least 11.5 feet bgs and for the Odor Control Slab the top of pile was assumed at a depth of at least 1.5 feet bgs with soil profile based on boring B-2-23. We evaluated the lateral capacity for ¼-inch, ½-inch, and 1-inch deflection at the top of the pile for the Sludge Tanks and ¼-inch, ½-inch, and ¾-inch deflection at the top of the pile for the Odor Control Slab. The results of our analyses are summarized in Table 4 for the Sludge Tanks and Table 5 for the Odor Control Slab. The results represent ultimate values and do not include a factor of safety. Plots of the lateral pile analysis, including deflection, shear, and moment profiles, are presented at the end of this report in Figures 3 through 6. The figures start with top of pile equal to depth of 0 feet.

TABLE 4. ULTIMATE LATERAL PILE CAPACITY – AUGERCAST PILES AT SLUDGE TANKS

PILE DIAMETER	LATERAL DEFLECTION (INCH)	FIXED HEAD CONDITION (AT BASIN)	
		LATERAL LOAD (KIPS)	MAXIMUM BENDING MOMENT (INCH-KIPS)
18-inch	¼	11	370
	½	17	640
	1	22	870
24-inch	¼	21	810
	½	31	1,360
	1	41	1,870

TABLE 5. ULTIMATE LATERAL PILE CAPACITY – AUGERCAST PILES AT ODOR CONTROL SLAB

PILE DIAMETER	LATERAL DEFLECTION (INCH)	FIXED HEAD CONDITION (AT BASIN)	
		LATERAL LOAD (KIPS)	MAXIMUM BENDING MOMENT (INCH-KIPS)
18-inch	¼	16	250
	½	25	510
	¾	32	720
24-inch	¼	24	610
	½	42	1,020
	¾	59	1,420

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5.4.4 Settlement

We estimate that the post-construction settlement of pile foundations, designed and installed as recommended, will be on the order of ¾-inch or less. Maximum differential settlement should be less than about one-half the post-construction settlement. Most of this settlement will occur rapidly as loads are applied. Pile foundations will effectively mitigate the liquefaction induced settlement discussed in the Seismic Hazard Considerations section of this report and long-term consolidation settlement potential.

5.4.5 Construction Considerations

The augercast piles should be installed to the recommended depth or tip embedment using a continuous flight, hollow-stem auger. We recommend that the augercast piles be installed by a contractor experienced in their placement and using suitable equipment. Excavation to the subgrade will likely reach loose/soft soil that will easily become disturbed and may not adequately support construction equipment without mitigation. Subgrade performance will be improved with appropriate dewatering. Additionally, a gravel working mat about 24 inches thick or other measures to distribute equipment loads may be required to support equipment during pile installation.

5.4.5.1 DRILLING AND GROUTING

The augercast piles generate cuttings as the soil is removed. As is standard practice, the pile grout must be pumped under pressure through the hollow stem as the auger is withdrawn. Maintenance of adequate grout pressure at the auger tip is critical to reduce the potential for encroachment of adjacent native soils into the grout column. Grout pumps must be fitted with a volume-measuring device and pressure gauge so that the volume of grout placed in each pile and the pressure head maintained during pumping can be observed. A minimum grout line pressure of 100 pounds per square inch (psi) should be maintained.

The action of the auger may tend to disturb the soil at the bottom of the drilled hole, which would result in decreased end-bearing capacity. In order to minimize the negative effects of this disturbance, we recommend that the pile contractor be required to rotate the auger following pumping of the first few cubic feet of grout and prior to auger withdrawal. This will mix any loose cuttings at the bottom of the hole with the grout, thus developing the required end-bearing capacity.

The glacial drift soil can have occasional cobbles and boulders and even clusters. It may be necessary to relocate some piles if refusal is encountered prior to achieving recommended embedment in the dense glacial layer.

5.4.5.2 AUGER WITHDRAWAL

The rate of withdrawal of the auger must remain constant throughout the installation of the piles in order to reduce the potential for necking of the piles. The rate of auger withdrawal should be controlled during grouting such that the volume of grout pumped is equal to at least 115 percent of the theoretical pile volume. A minimum head of 10 feet of grout should be maintained above the auger tip during withdrawal of the auger to maintain a full column of grout and prevent hole collapse. Failure to maintain a constant rate of withdrawal of the auger will result in immediate rejection of that pile. Reinforcing steel for bending and uplift should be placed in the fresh grout column as soon as possible after withdrawal of the auger. Centering devices should be used to provide concrete cover around the reinforcing steel.

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5.4.5.3 CONSTRUCTION SEQUENCING

We recommend that there be a waiting period of at least 12 hours between the installation of piles spaced closer than 8 feet, center-to-center. This waiting period is necessary to avoid disturbing the curing concrete in previously cast piles.

5.4.5.4 VERIFICATION AND TESTING

It should be noted that no direct information regarding the capacity of augercast piles (e.g., driving resistance data) can be obtained while this type of pile is being installed. Therefore, we recommend that pile installation operations be monitored by the Geotechnical Engineer or his representative. The Geotechnical Engineer will observe the drilling operations, monitor grout injection procedures, record the volume of grout placed in each pile relative to the calculated volume of the hole, and evaluate the adequacy of individual pile installations. We also strongly recommend that a pre-construction meeting take place with the pile contractor, the owner, and the Geotechnical Engineer to discuss pile construction techniques.

Federal Highway Administration (FHWA) Geotechnical Engineering Circular No. 8 – Design and Construction of Continuous Flight Auger Piles outlines guidelines for pre-production, verification load testing, and integrity testing. Testing could include pre-production static load testing, rapid dynamic test (RDT) or dynamic load test (DLT) for verification, and sonic echo testing for integrity. In our experience, this type of testing is uncommon except for large projects or projects of a critical nature. We recommend that this document be consulted and an appropriate testing program selected. At a minimum, we recommend the geotechnical observations described above along with appropriate materials testing to verify quality of grout and steel materials.

5.5 SHALLOW FOUNDATION RECOMMENDATIONS – PILE SUPPORTED MAT FOUNDATION

We understand that the proposed Sludge Tank foundations be supported on a pile supported mat foundation

We anticipate that the mat foundation will be supported on a working platform consisting of 12 to 18 inches of crushed rock

We recommend that all footing excavations be observed by a representative of our firm immediately prior to construction of a working pad and any reinforcing steel and structural concrete placement for footings, to confirm that the bearing surface has been prepared in a manner consistent with our recommendations and that the subsurface conditions are as expected.

Exterior footings should be founded at least 18 inches below the lowest adjacent finished grade. Interior footings should be founded a minimum of 12 inches below lowest adjacent soil grade.

5.6 ADDITIONAL DESIGN FOR BELOW-GRADE STRUCTURES

5.6.1 Lateral Earth Pressures

Lateral soil pressures acting on the retaining walls will depend on the nature and density of soil behind the wall, the amount of lateral wall movement which occurs as backfill is placed, and the inclination of the backfill surface. For walls free to yield at the top at least one thousandth of the wall height (i.e., wall height times 0.001), soil pressures will be less than if wall movement is restrained. We recommend that walls free

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to yield at the top and supporting horizontal backfill be designed using an equivalent fluid density of 35 pounds per cubic foot (pcf). We recommend that walls that extend below groundwater levels be designed using an equivalent fluid density of 80 pcf to account for combined soil plus hydrostatic pressures unless drainage provisions are included. If the walls will be restrained against movement, we recommend using an equivalent fluid density of 55 pcf above the water table and 90 pcf below the water table.

We also recommend a uniformly distributed seismic surcharge of 9H pounds per square foot (psf) (H = Height of wall) be applied to the wall with a corresponding reduction in the factors of safety to 1.1 or greater. Lateral pressure resulting from seismic surcharge loading is additive to lateral soil pressures computed as recommended above.

Surcharge loading should be added to all below-grade walls where appropriate. If traffic can be within about 10 feet of the top of the wall, we recommend that the walls be designed for a uniform horizontal surcharge load on the order of 70 psf, which represents a 250 vertical traffic surcharge. For design purposes, this is equivalent to assuming approximately 2 additional feet of soil above site grades using the equivalent fluid densities described above. Temporary surcharge loading during construction resulting from equipment and soil stockpiles should be evaluated by the contractor.

In order to prevent overstressing the concrete retaining walls and causing bulging or rotation, we recommend that structural fill placed against the back of the wall be compacted with lighter weight hand-operated equipment and within the range of 90 to 92 percent of the maximum dry density (MDD). Backfill should be placed after the concrete has had sufficient time to cure and develop the necessary strength.

5.6.2 Base Friction and Passive Resistance

Lateral foundation loads may be resisted by passive soil pressures on the sides of the buried foundation element and by friction on the bases of the foundation. For foundation elements supported in accordance with our recommendations on 18-inches minimum of crushed surfacing base course (CSBC), the allowable frictional resistance may be computed using a coefficient of sliding of 0.45 applied to vertical dead-load forces.

The passive resistance of backfilled soils may be computed using an equivalent fluid pressure of 300 pcf or 150 pcf if below groundwater, where the foundation element is surrounded by on-site soil or structural fill compacted as described in the “Fill Placement and Compaction” section of this report. The passive earth pressure value assumes that the adjacent grade is level and the compacted structural fill extends a minimum distance of 1.5 times the footing depth beyond the edge of the foundation. The top foot of fill material should generally be neglected when calculating passive lateral earth pressures. A factor of safety of about 1.5 has been applied to the above values.

5.6.3 Buoyancy and Uplift

We recommend that the structures that extend below the groundwater table be designed to resist hydrostatic uplift. Without drainage provisions, the excavation backfill could have the potential to collect water in the lower permeability native soil and create a “bathtub” effect. The structures could alternatively be designed for hydrostatic uplift based on a representative groundwater level or planned relief drain elevation.

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Resistance to uplift can be developed by the dead weight of the structure and friction along the sides of the structure. Frictional resistance can be computed using a coefficient of friction of 0.35 applied to the lateral soil pressures. This coefficient of friction is an allowable value and includes a factor of safety of approximately 1.5. We recommend that lateral soil pressures for uplift resistance be computed using an equivalent fluid density of 35 pcf above the groundwater table and 18 pcf below the groundwater table. In addition to the above means of resisting uplift, the structure may be constructed with a base that extends beyond the structure walls so that the weight of overlying soil resists a portion of the uplift. For this purpose, the overlying backfill may be assumed to have a submerged unit weight of 60 pcf.

5.6.4 Buried Slabs

Buried slabs, such as for the tops of utility vaults or tunnel roofs, should be designed for a uniform pressure of 130 psf per foot of fill placed above the slab. Other loading, such as traffic surcharge, should also be applied to these slabs.

5.7 PIPE DESIGN CONSIDERATIONS

Various piping and utility corridors will be required to connect the new facilities to the existing infrastructure. We should review material types and depths during final design.

Zones of perched groundwater seepage should be anticipated. The groundwater table will likely be encountered at depths of 5 feet throughout the site. The contractor should anticipate, at a minimum, all utility excavations will require a trenchbox for sidewall support and sumps and pumps to control groundwater seepage. At locations where nearby infrastructure must be protected, shoring that limits lateral movement of soil combined with more aggressive dewatering, as described in this report, may be necessary.

5.7.1 Utility Connection to existing Scrubber Building

There will be new utility connections to the existing Scrubber Building (to be the Sludge Storage Building). The estimated liquefaction settlement is expected to be 1½ to 3 inches. The proposed Sludge Tanks will be pile supported with anticipated foundation settlement of 1-inch or less. Therefore, any utility connections should include adequate flexibility in design to accommodate expected differential settlement.

5.8 CORROSION POTENTIAL

Corrosion potential of selected soil samples was conducted based on laboratory chemical testing subcontracted to Norton Corrosion of Woodinville, Washington. Laboratory testing included pH, chloride, sulfate, sulfide, redox potential, and resistivity, the results of which are summarized in Table 6 below, with the full laboratory results presented in Appendix B. The results of the chemical testing were compared to critical values presented in FHWA-RD-89-186 (FHWA 1990) for evaluating aggressiveness of soil environment for steel reinforcement.

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TABLE 6. RESULTS OF LABORATORY TESTING FOR CORROSION POTENTIAL

BORING NO.	SAMPLE NO. (DEPTH)	PH	SULFIDE (PPM)	REDOX POTENTIAL (MV)	RESISTIVITY (OHM/CM) NATIVE	RESISTIVITY (OHM/CM) SATURATED	CHLORIDE (PPM)	SULFATE (MG/L)
B-1	S-2 (2.5 feet)	5.9	ND*	104.2	8,700	3,800	93	32
B-1	S-4 (7.5 feet)	7.0	ND*	151.2	43,000	7,100	<30	33
B-2	S-2 (2.5 feet)	6.6	ND*	140.5	73,000	15,000	<30	IS
B-2	S-4 (7.5 feet)	6.9	ND*	173.2	9,800	5,000	<30	<2

Notes:
mg/L = milligrams per liter; mV = millivolts; ohm/cm = ohms/centimeter; ppm = parts per million; ND = not detected; IS = insufficient sample

Based on the referenced document, soils with a redox potential between100 and 200 millivolts (mV) are considered to be moderately corrosive. Soils with a resistivity between 2,000 and 5,000 ohms per centimeter (ohm/cm) are considered to be moderately corrosive; soils with a resistivity between 5,000 and 10,000 ohm/cm are considered mildly corrosive; and soils with a resistivity greater than 10,000 ohm/cm are considered to be non-corrosive. The same FHWA document presents the following recommended electrochemical limits for fill soils:

pH	greater than 4.5 and less than 9.5
chlorides	less than 100 parts per million (ppm)
sulfates	less than 200 ppm
resistivity	greater than 5,000 ohm/cm

Based on these limits, all the samples tested have at least some corrosion potential to steel reinforcement.

5.9 EARTHWORK

5.9.1 General

Excavation for the proposed sludge tank foundations are anticipated to extend to depths of 11.5 feet bgs. Temporary shoring and dewatering is anticipated to be limited. The site soils that will be excavated generally consist of various fill soils. These are moisture-sensitive soils and are susceptible to disturbance by construction equipment during wet weather. We expect that stormwater would be contained in the excavations.

Temporary erosion control measures should be used during construction depending on the water, location, soil type, and other factors. Temporary erosion protection (RECPs) may be necessary to reduce sediment transport until vegetation is established or permanent surfacing applied. Appropriate BMPs should be incorporated into the temporary erosion and sediment control plan developed by the civil engineer. We are available to provide input if requested.

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5.9.2 Site Preparation

The proposed improvements will be constructed in areas currently surfaced with an existing building, manicured grass, and pavement. We recommend that any existing vegetation and topsoil or other surfacing be stripped from all new building and pavement areas. All existing foundation elements and utilities should also be removed and backfilled with structural fill per section below. For planning purposes, we recommend stripping depth in vegetated areas in the range of 3 to 6 inches, and in currently developed areas in the range of 6 to 12 inches. Roots should be grubbed to a diameter less than 1 inch. The stripped material should be wasted off-site. We recommend that the existing pavement be removed from the existing driveway or sidewalk areas where necessary and a uniform subgrade be prepared in all areas for support of the new pavement section.

The prevailing site soils are moisture-sensitive and will be difficult to operate on and very difficult to compact during wet weather. Rubber-tired vehicles can easily disturb this type of soil.

We recommend that the subgrade be evaluated by a representative of GeoEngineers to confirm the subgrade is adequate for structural support. We recommend that the subgrade for structural areas be thoroughly proofrolled with heavily loaded rubber-tired construction equipment if site preparation is done during extended dry weather conditions. The proofrolling should be observed by one of our geotechnical engineers, who will evaluate the subgrade. In areas where adequate compaction cannot be achieved, additional overexcavation of soft, organic, or deleterious materials may be required as directed by the field engineer.

5.9.3 Base Preparation

The base of excavations for below grade structures will vary based on historic grading, site geology, and groundwater level. The subgrade soils for the sludge tank foundations could be somewhat variable and will most likely consist of existing fill placed following previous peat removal activities. We therefore recommend that a minimum 12-inch layer of clean sand and gravel (Select Import Fill as described in this report) be placed over the subgrade; however a thicker layer, up to 24 inches, or other means of distributing equipment loads, may be required to support construction equipment during wet weather.

For conventional mat foundations over ground improvement, we recommend that the structural fill be compacted to at least 95 percent of the MDD. It will likely be necessary to install a series of sumps through the sand and gravel and into the underlying material to capture and pump groundwater and rainwater that will flow into the excavation.

5.9.4 Temporary Excavations

All excavation activities must be completed in accordance with applicable county, state, and federal safety standards. The on-site soils can generally be excavated using conventional earthmoving equipment, although some large cobbles should be expected. Regardless of the soil type encountered in the excavation shoring, trench boxes or sloped sidewalls will be required for excavations deeper than 4 feet under Washington State Administrative Code (WAC) 296-155, Part N. The stability of open-cut slopes is a function of soil type, groundwater level, slope inclination, and nearby surface loads. The use of inadequately designed open cuts could impact the stability of adjacent structures and existing utilities and endanger personnel. We expect that much of the trench excavations will be made as open cuts in conjunction with the use of sloped sidewalls and/or a trench box for shielding workers.

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In our opinion, the contractor will be in the best position to observe subsurface conditions continuously throughout the construction process and to respond to variable soil and groundwater conditions. Therefore, we recommend that the contractor have the primary responsibility for deciding whether to use an open-cut slope rather than some form of temporary excavation support and/or dewatering strategies. Temporary excavation considerations for the various project elements are discussed below:

Soil and groundwater conditions within the areas of previous peat removal could be extremely variable. If significant quantities of clean granular fill were used as backfill, groundwater flow into excavations could be rapid. Groundwater seepage may also occur where layers/lenses of granular material occur within finer grained fill.

We suggest that the contractor "pothole" the areas of excavation and alignment of any utility trenches in advance of opening the excavation to put an excavation strategy/dewatering plan together as appropriate. Dewatering considerations are provided in a subsequent section of this report.

5.9.4.1 TEMPORARY CUT SLOPES

The state regulations allow temporary slopes for excavations less than 20 feet deep, from 0.75H:1V to 1.5H:1V depending upon soil type. The regulations assume that surface loads such as construction equipment and storage loads will be kept a sufficient distance away from the top of the cut so that the stability of the excavation is not affected. Based on our explorations, the site soils are as follows:

- The existing fill and loose to medium dense granular beach deposit soils are considered to be a "Type C" soil by the regulations, which has an allowable temporary maximum slope angle of 1.5H:1V.

The regulations and maximum slope angles presented assume that groundwater seepage is not present in these soils. Therefore, the soils must be above the groundwater level and/or in a dewatered condition.

If temporary cut slopes experience excessive sloughing or raveling during construction, it may become necessary to modify the cut slopes to maintain safe working conditions and protect adjacent facilities or structures. Slopes experiencing excessive sloughing or raveling can be flattened, regraded to add intermediate slope benches, or additional dewatering can be provided if the poor slope performance is related to groundwater seepage. Berms, hay bales or other provisions should be installed along the top of excavations to intercept surface runoff to reduce the potential for sloughing and erosion of cut slopes during wet weather.

5.9.4.2 TEMPORARY SHORING – TRENCH BOXES

We recommend that a shoring system be used where excavations are located adjacent to existing utilities, roadways, or structures where soil movement or ground loss could result in damage to these facilities. Generally, a trench box is not considered appropriate in areas where soil movement adjacent to the trench is unacceptable. Typically, a trench box is used to protect workers from injury should the sidewall collapse. If a sidewall collapses, a contractor typically will backfill the void space in the trench box to the extent practical. Upon completion of the work the contractor will then pull the trench box out and the sidewalls cave and surface distress or disruption occurs.

A trench box can be used where sidewall support is required provided that it is (1) designed for anticipated earth pressures and hydrostatic pressures if appropriate and (2) the installation, moving and backfilling

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can be accomplished in such a manner that significant yielding does not occur. Braced or unbraced shoring (several types of adjustable braced trench shoring systems are available) of various types could be used where protection of existing infrastructure is necessary.

If a trench box is used and the soils are dewatered below the base of the excavation (prior to excavation), yielding/movement of the sidewalls is likely to occur within a 1.5H:1V slope as measured from the bottom of the excavation. If the soils are not dewatered to at least 1 foot below the bottom of the trench prior to and during excavation, the area of disturbance could be greater than a 1.5H:1V slope as measured from the bottom of the excavation. The following should be implemented for the trench box shoring systems for the project:

- At locations where settlement could be detrimental to adjacent structures, utilities, or pavements, the shoring system should be designed to prevent significant lateral movement of the existing soils.
- Precautions should be taken during removal of the shoring or sheeting materials to minimize disturbance of the pipe, underlying bedding materials, and natural soils.
- Trench boxes should be of sufficient size, both vertically and horizontally, to support the excavation without excessive deformation of the natural soils.
- The open excavations should be backfilled as soon as practical after the shoring has been removed.
- Heavy construction equipment, construction materials, and excavated soil should not be allowed within a distance, measured from the edge of the excavation, equal to half the depth of the excavation, unless the shoring system has been designed for the additional lateral pressure.

Because of the diversity of available shoring systems and construction techniques, the design of temporary shoring is most appropriately left up to the contractor proposing to complete the installation. We recommend that the shoring be designed by an engineer licensed in Washington, and the PE stamped shoring plans and calculations be submitted to the engineer prior to construction.

5.9.4.3 TEMPORARY SHORING – SHEETPILES

We recommend that a shoring system be used where excavations are located adjacent to existing utilities, roadways, or structures where soil movement or ground loss could result in damage to these facilities.

We anticipate that construction of the Sludge Tank will be completed using at least a partially shored excavation due to the depth of the excavation and the presence of groundwater. A sloped excavation may be feasible at some locations provided that aggressive dewatering is completed concurrently and space constraints will not prohibit relatively flat temporary slopes. A sheet pile system extending into the underlying clayey glacial drift at the site will retain the soils and serve as a groundwater cutoff to minimize the quantity of water that will need to be pumped and discharged. For deeper excavations, where the wall is greater than about 10 feet high, it may be necessary to use a row of tieback anchors or deadmen to resist the additional pressure due to hydrostatic pressures. We recommend that the shoring be designed by an engineer licensed in Washington, and the PE stamped shoring plans and calculations be submitted to the Engineer prior to construction. The following paragraphs present suggested design parameters based on conditions encountered at the site; however, as stated before, the contractor will be responsible for shoring design.

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The soil conditions encountered within our explorations generally consist of existing fill and beach deposits overlying generally clayey glacial drift. Groundwater is assumed to be approximately 5 feet bgs. Earth pressure diagrams for sheet pile shoring are provided in Figure 7 for the project area.

5.9.5 Structural Fill

Structural fill materials should be free of debris, organic contaminants, and rocks or rock fragments larger than 6 inches or half the lift thickness, whichever is smaller. All fill placed within the building and pavement areas should be placed as structural fill. Structural fill should be placed in horizontal lifts not exceeding 10 inches in loose thickness or that necessary to obtain the specified compaction with the equipment used. Each lift must be thoroughly and uniformly compacted as previously recommended.

As the amount of fines (material passing the U.S. No. 200 sieve) increases in a soil it becomes more sensitive to small changes in moisture content. During wet conditions, adequate compaction becomes more difficult to achieve. Generally, soils containing more than about 5 percent fines by weight cannot be properly compacted when the moisture content is more than a few percent from optimum.

Sufficient earthwork monitoring and a sufficient number of in-place density tests should be performed to evaluate fill placement and compaction operations and to confirm that the required compaction is being achieved.

5.9.5.1 SUITABILITY OF ON-SITE MATERIALS

The on-site materials within much of the proposed excavation depth for below grade structures consist fill of variable composition including sand, silt, and clay, with limited quantities of cleaner sand (SP-SM and SP). Material excavated from below the water table will not be suitable for use as backfill unless the sand is allowed to drain.

Silty sand fill encountered during our explorations had moisture contents ranging from slightly above to well above optimum moisture content. This material is also highly moisture sensitive. In our opinion the silty sand encountered may be used at the time of construction if approved by the geotechnical engineer based on the field moisture content and intended use. If significant quantities of native or previously imported sand with silt (SP-SM) or sand (SP) are encountered, this material will also likely be suitable for general backfill. These materials will likely need to be moisture conditioned to achieve suitable compaction and additional compactive effort will be required. It may be necessary for the contractor to segregate materials in order to use on-site soils for backfill. For planning purposes in structural support areas below foundations and slab-on-grade, we recommend a select import fill where structural fill is required.

5.9.5.2 SELECT IMPORT FILL

If wet weather or the moisture content precludes the use of onsite materials structural fill, we recommend using a select import fill to complete the backfilling site excavations. The select import fill should consist of sand and gravel with a fines content less than 5 percent based on that portion passing the ¾-inch sieve. Suitable Washington State Department of Transportation (WSDOT) Standard Specifications include Gravel Borrow (9-03.14) minimum 30 percent on U.S No. 4 sieve and fines content limited as noted.

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5.9.5.3 FILL PLACEMENT AND COMPACTION

Structural fill should be placed in 8- to 12-inch loose lifts, or that thickness necessary to achieve the required compaction using the mechanical equipment chosen by the contractor. We recommend that the MDD be estimated based on ASTM International (ASTM) D 1557.

Table 7 below provides a summary of recommended imported structural fill materials and compaction standards.

TABLE 7. SUGGESTED FILL MATERIAL COMPACTION AND SPECIFICATION

FILL AREA	COMPACTION	SUGGESTED SPECIFICATION
Structural fill below foundations	95% MDD	WSDOT Gravel Borrow 9-03.14(1) with minimum 30 percent on U.S No. 4 sieve; or WSDOT Crushed Surfacing 9-03.9(3)
Retaining wall backfill	90 to 92% MDD within 5 feet of wall	WSDOT Gravel Borrow 9-03.14(1); or WSDOT Gravel Backfill for Drains 9-03.12(4)
Structural fill below pavements, driveways, and sidewalk	90% MDD except 95% in upper two feet below pavement section	WSDOT Gravel Borrow 9-03.14(1)
Gravel base for pavement	95% MDD	WSDOT Aggregate for Gravel Base 9-03.10
Crushed surfacing base/top course	95% MDD	WSDOT Crushed Surfacing 9-03.9(3)

Notes:
AASHTO - American Association of State Highway and Transportation Officials

5.9.6 Wet Weather Earthwork and Erosion Control

General recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. These recommendations should be incorporated into the contract specifications.

- Earthwork should be performed to limit exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement and compaction of clean fill. The size and type of construction equipment used may need to be limited to prevent soil disturbance.
- The ground surface within the construction area should be sealed by a smooth drum vibratory roller, or equivalent, and under no circumstances should soil be left uncompacted and exposed to moisture that can erode off the jobsite.
- Excavation and placement of structural fill and trench backfill material should be performed under sufficient observation and testing to confirm that the work is completed in accordance with the project specifications and the recommendations contained herein.
- Soil stockpiles should be covered with plastic sheeting if wet weather conditions are anticipated.
- Silt fences should be installed between the work area and sensitive areas to prevent transport of sediment beyond the work area.

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5.10 CONSTRUCTION DEWATERING

The excavations for the Sludge Tanks and some excavations for utility piping will likely extend to near or below the groundwater table during most times of the year. Zones of seepage will likely be encountered in other shallower excavations and for excavation of the below grade sludge tank foundation. Where temporary construction slopes with open cuts will be used, we expect that a combination of open pumping and well points will be required to adequately dewater site soils. It is likely that sumps and pumps with limited shoring will be sufficient to dewater if the water level needs to be lowered only a few feet. Extensive dewatering of compressible soils can increase effective stresses in the soil and induce settlement. The Contractor should have the responsibility to determine the dewatering measures needed for the project.

5.10.1 Open Pumping

This dewatering method involves removing water that has seeped into the excavation by pumping from a sump that has been excavated at one end of the excavation or trench. Drainage ditches that are connected to the sump are typically excavated along the sidewalls at the base of the excavation or trench. The excavation for the sump and the drainage ditches should be backfilled with gravel or crushed rock to reduce the amount of erosion and associated sediment in the water pumped from the sump. In our experience, a slotted casing, perforated 5-gallon bucket or 55-gallon drum that is installed in the sump backfill provides a suitable housing for a submersible pump.

The amount of water removed from the excavation by open pumping should be minimized because of high turbidity levels. Temporary storage of dewatering effluent from the sumps in a settlement tank or basin may be required to meet National Pollution Discharge Elimination System (NPDES) construction storm water discharge permit requirements and reduce sediment content prior to discharging the water to surface water courses.

5.10.2 Wellpoints

Wellpoints are effective for dewatering all types of soils, whether pumping small amounts of water from silt or large quantities of water from coarse sand and gravel. The volume of water generated by a wellpoint system is typically less than the volume generated by a corresponding system of pumped wells because the wellpoints are generally completed at a shallower depth. Because of the shallower completion depth, the volume of aquifer that contributes water to a wellpoint system is less than for a comparable deep well system. In our opinion, well points will be a more effective dewatering system than pumped wells, given the site conditions. Wellpoint systems are most suitable for dewatering shallow excavations where the water table must be lowered no more than about 15 feet below ground surface or the header surface. Multiple wellpoint stages are generally required beyond that depth because of the physical limitations of suction lift. Dewatering can be accomplished at depths greater than 15 feet where the excavation can be open cut to permit installation of the wellpoint header system below original grade. This technique increases the depth to which the water table can be lowered with wellpoints. The wellpoints would likely need to be installed on less than 10-foot centers (typically 4 to 8 feet) to be effective and as close as possible to the edge of the excavation. The wellpoint screens should be filter packed with graded sand or sand and fine gravel to improve pumping efficiency and minimize the discharge of turbid water. Wellpoints must be sealed to a depth of at least 8 feet with hydrated bentonite chips forming a surface seal to encourage the development of a partial vacuum around each wellpoint.

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5.10.3 Dewatering Qualifications and Experience

We strongly recommend that dewatering, where used, be performed by a contractor or subcontractor with dewatering experience. If necessary to use well points, we recommend an experienced dewatering specialist contractor with competent and experienced staff who can demonstrate successful deployment and operation of vacuum wellpoint systems in the Pacific Northwest over the past 10 years, and who can install systems that use high capacity electronically controlled and monitored vacuum pumps. If active dewatering using wells or wellpoints will be used, we recommend a Dewatering Plan be required as a submittal from the contractor at least two weeks prior to dewatering, that fully describes the dewatering approach, including material and equipment specifications, calculations, and supporting assumptions to ensure that dewatering is achieved to not less than 1 foot below excavation subgrade. The Dewatering Plan should include an appropriate survey program identifying critical infrastructure that will be monitored, schedule of survey times, and appropriate action plans if subsidence is observed. The Dewatering Plan should be prepared by or under the direct supervision of a Professional Engineer and/or Licensed hydrogeologist registered in the State of Washington and having at least 5 years of demonstrated experience in the design and operation of vacuum wellpoint dewatering systems.

5.10.4 Dewatering Limitations

Our services were provided to assist in the assessment of construction dewatering requirements for the planned wastewater treatment plant expansion project. Our dewatering recommendations are based on evaluation of the available geotechnical information. Groundwater can create a safety threat and can seriously compromise arrangements for shoring excavations. Also, given the potential for natural variation in geologic formations, differing site conditions may be encountered that could lead to substantially different groundwater inflows and dewatering challenges than are presented in this evaluation. We did not perform pumping tests or other detailed hydrogeologic evaluations and this information is presented for use by the contractor but is not intended to dictate designs.

5.11 DRAINAGE CONSIDERATIONS

The existing near surface site soils consist of fill from previous peat removal. The groundwater elevation varies by season and was observed at approximately 5 feet bgs based on information in available environmental reports. The existing WWTP infrastructure includes a below grade utilidor in the adjacent roadway. Based on all these factors, stormwater infiltration does not meet feasibility criteria. We anticipate that stormwater will be routed to existing collection systems.

6.0 Geotechnical Design and Construction Observation Services

The project has variable subsurface conditions and some complex geotechnical issues. We recommend that GeoEngineers provide consultation during final design and monitoring during construction. It is our experience that providing geotechnical support to the design team during final design, bidding, preconstruction meetings, and during construction facilitates the contractor, progress, and schedule, and helps protect the owner from change orders. On this project, we recommend geotechnical involvement in at least the following aspects of the project:

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- Final design of project structures
- Review of pile foundation or ground improvement plans
- Review of shoring submittal and observation during construction
- Review of dewatering plan and consultation during construction
- Approval of backfill materials and sources
- Observation of pile or ground improvement installation, as necessary
- Evaluation of subgrade conditions for shallow foundation support
- Evaluation of subgrade conditions for pipeline, pavement, and other infrastructure
- General consultation to the owner, design team and contractor, as requested

7.0 Limitations

We have prepared this report for use by the City of Bellingham, Carollo Engineers and their authorized agents for the proposed Post Point Primary Sludge Tank Replacement located in Bellingham, Washington.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record. Please refer to the appendix titled Report Limitations and Guidelines for Use for additional information pertaining to use of this report.

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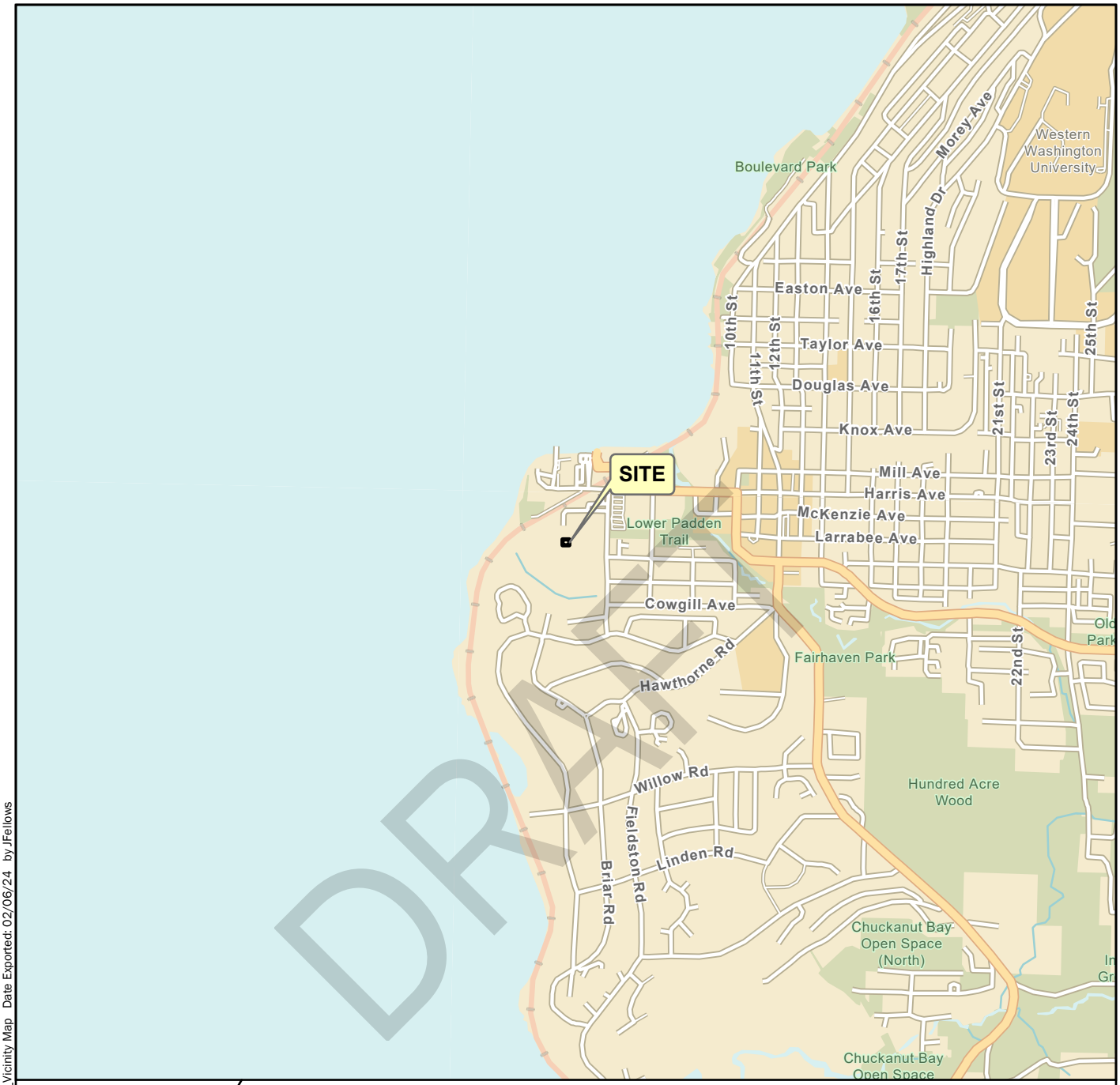
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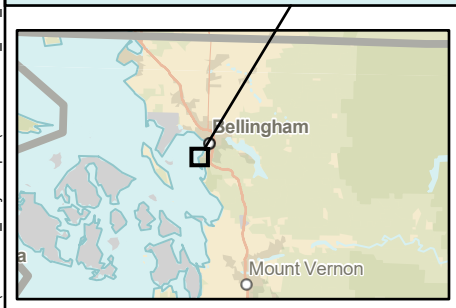
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Figures

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N

0 2,000

Feet

Source(s):
- ESRI

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

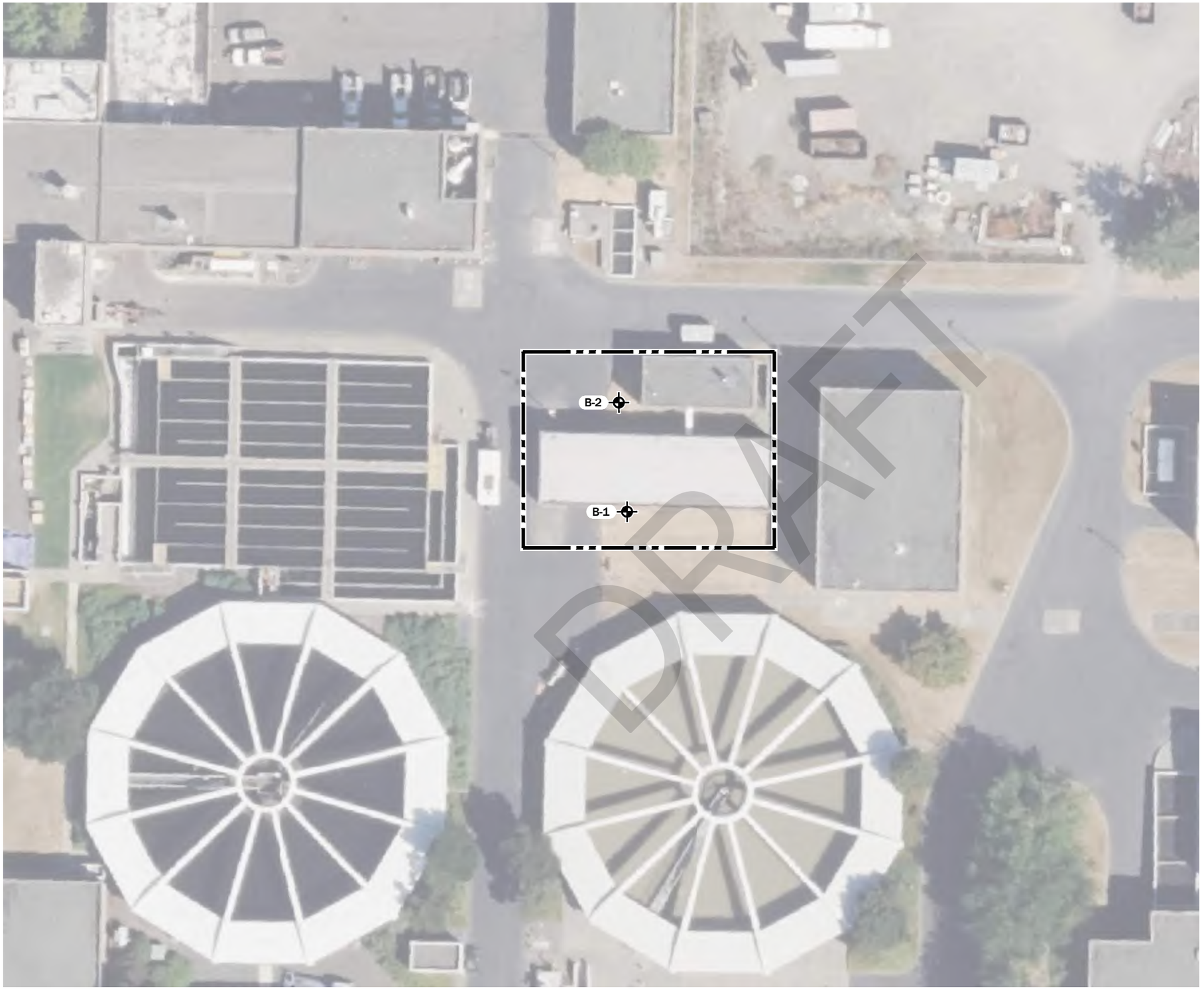
Vicinity Map

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

GeoEngineers

Figure 1

P:\0\0356185\GIS\0356185_Project\0356185_Project.aprx\0356185000_F01_Vicinity Map Date Exported: 02/06/24 by JFellows



Legend

Site Boundary

B-1 Boring by GeoEngineers, Inc., 2023

Source(s):
- Aerial from Microsoft Bing

Projection: WA State Plane, North Zone, NAD83, US Foot

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

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Feet

Site Plan

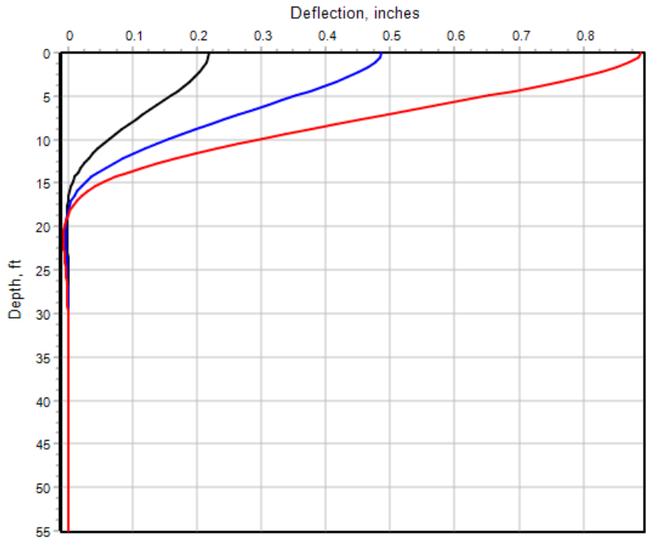
Post Point Primary Sludge Tank Replacement
Bellingham, Washington

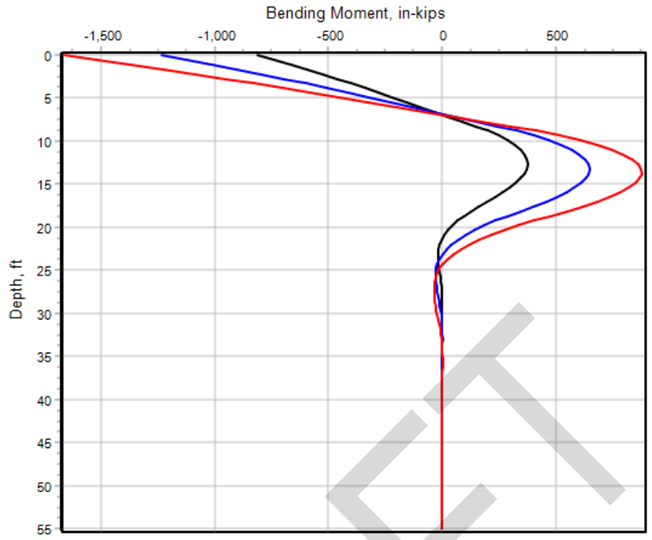
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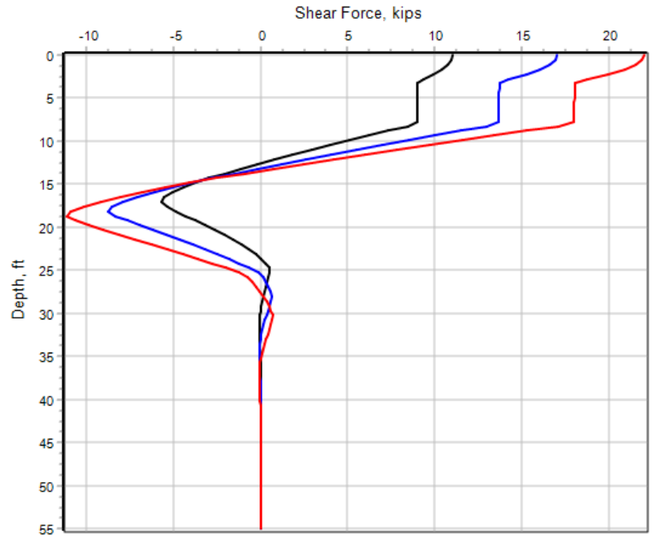
Figure 2

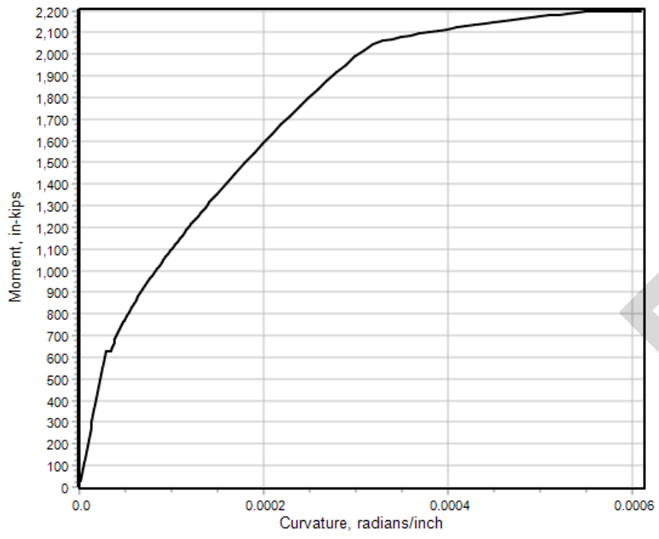
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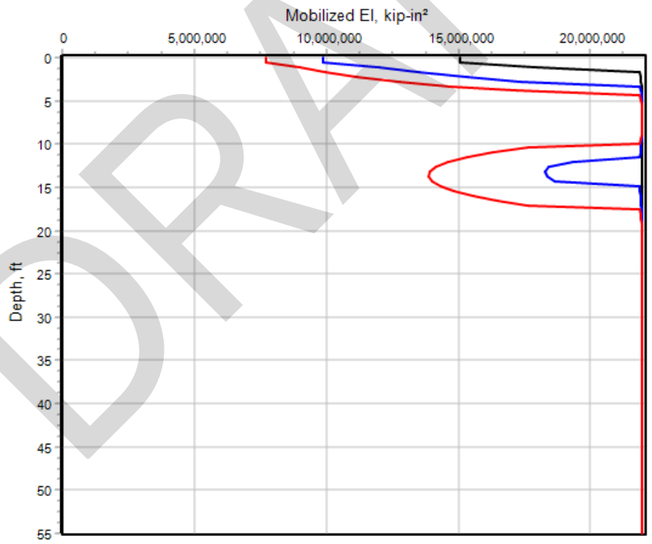
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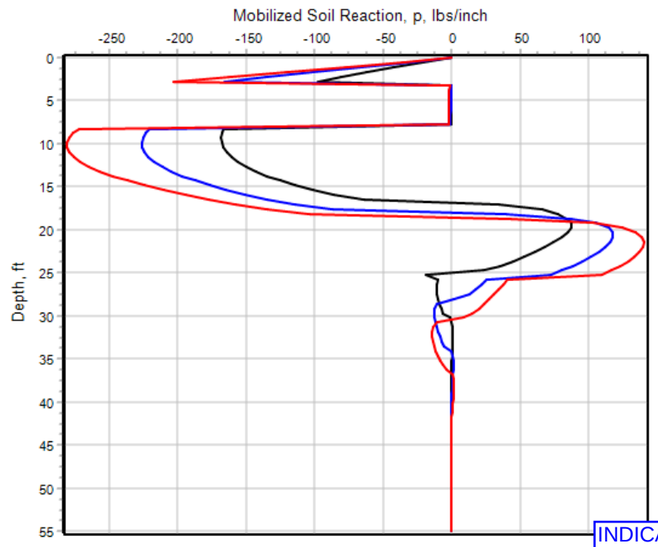












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4500 PSI

INDICATE FIXED PILE HEAD DEPTH BELOW GRADE

Assumptions

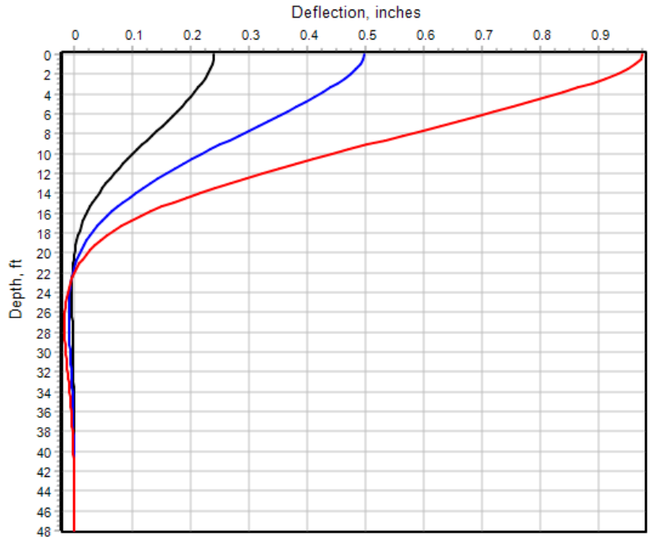
- 1.5-foot diameter Round Concrete Shaft (Bored Pile)
- 4,000 psi Concrete with 1% Steel Reinforcement
- Fixed-head condition
- Horizontal ground surface
- Single shaft with no group effects or p-multipliers
- 170 Kip vertical load, 11, 17 and 22 Kip lateral loads

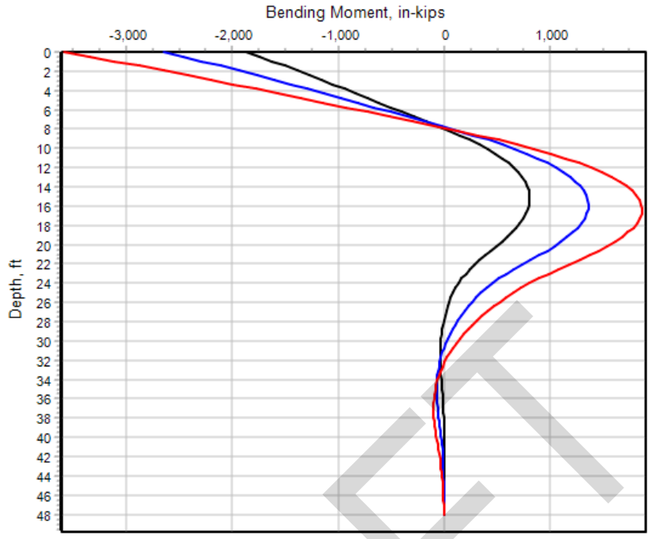
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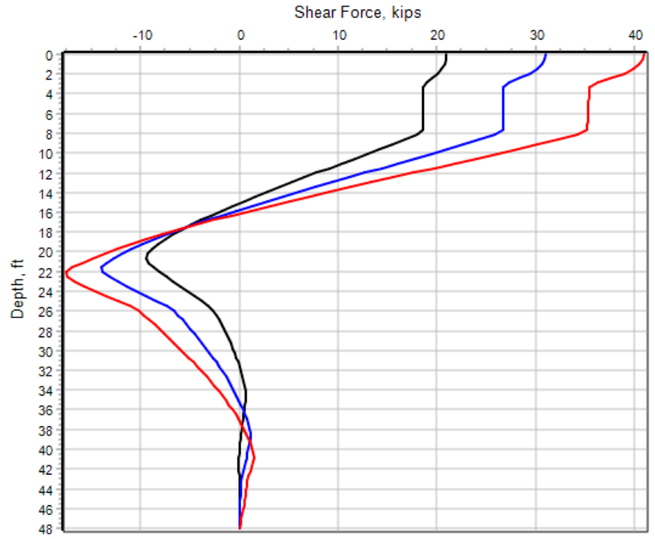
LPile Output Plots – 18-inch Diameter Shaft
Fixed Head

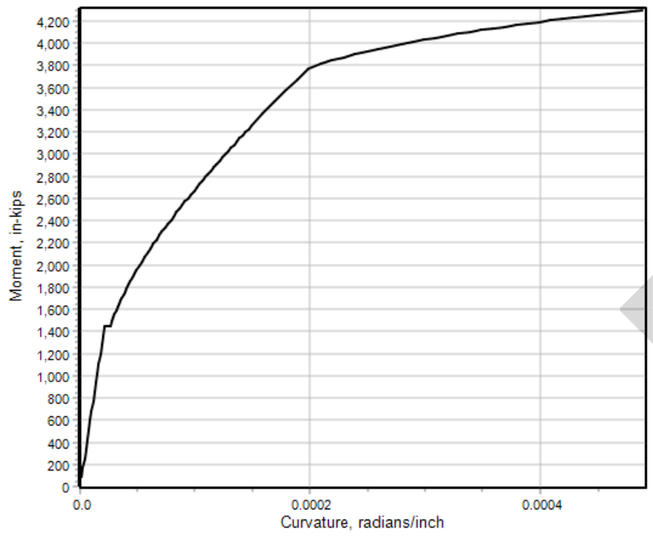
Post Point Sludge Tank Replacement
Bellingham, Washington

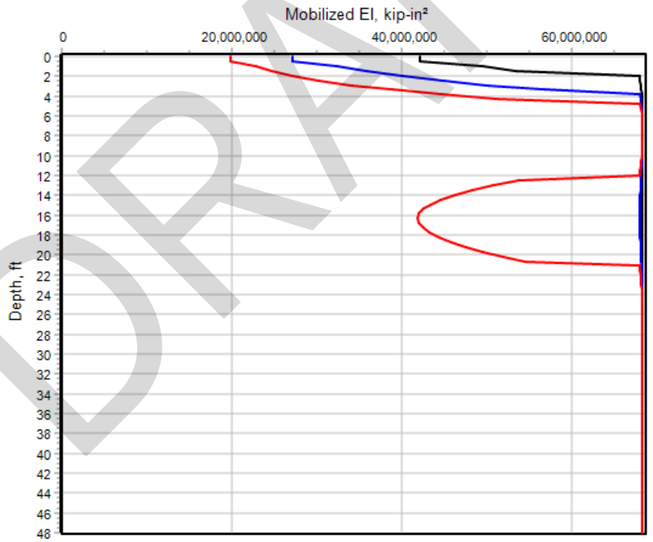
GeoEngineers | **Figure 3**

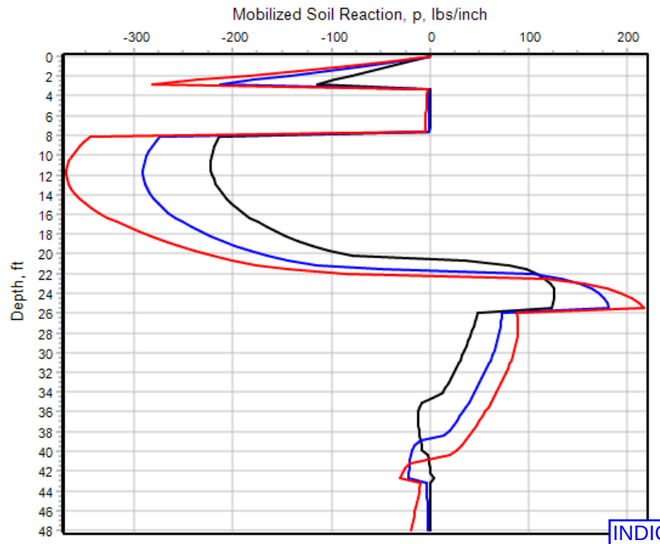












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4500 PSI

Assumptions

- 2-foot diameter Round Concrete Shaft (Bored Pile)
- 4,000 psi Concrete with 1% Steel Reinforcement
- Fixed-head condition
- Horizontal ground surface
- Single shaft with no group effects or p-multipliers
- 270 Kip vertical load, 21, 31 and 41 Kip lateral loads

Reference: LPILE v2019.11.02 (Ensoft)

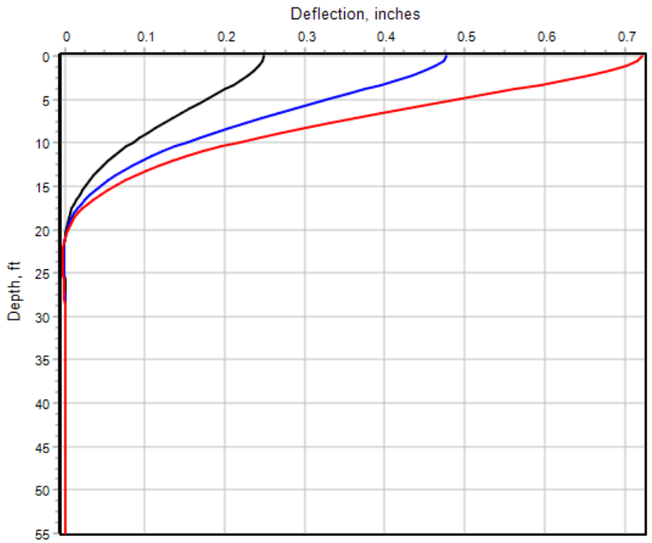
INDICATE FIXED PILE HEAD DEPTH BELOW GRADE

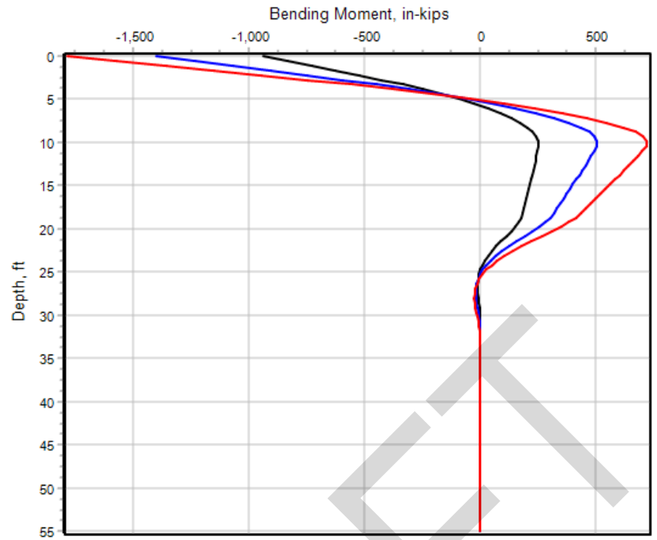
LPile Output Plots – 24-inch Diameter Shaft
Fixed Head

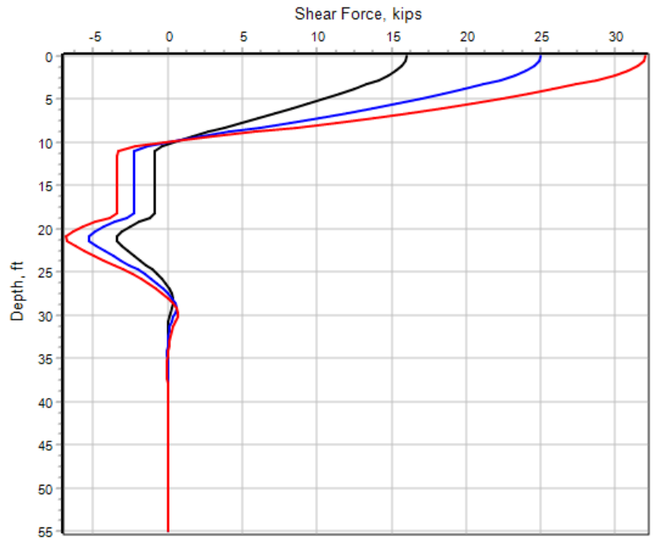
Post Point Sludge Tank Replacement
Bellingham, Washington

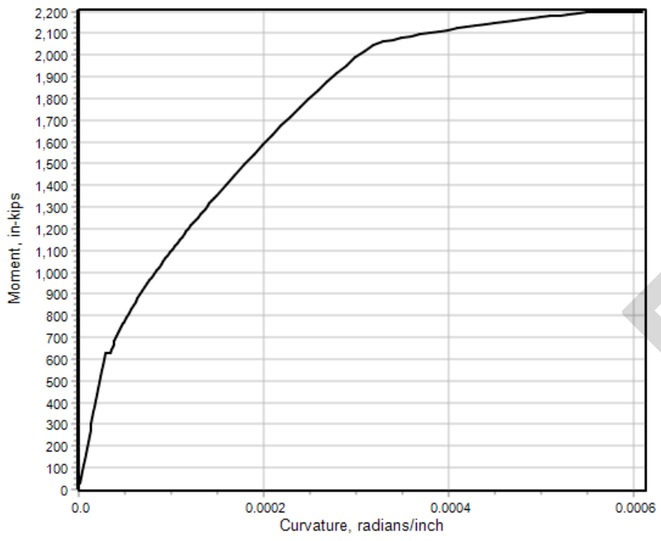
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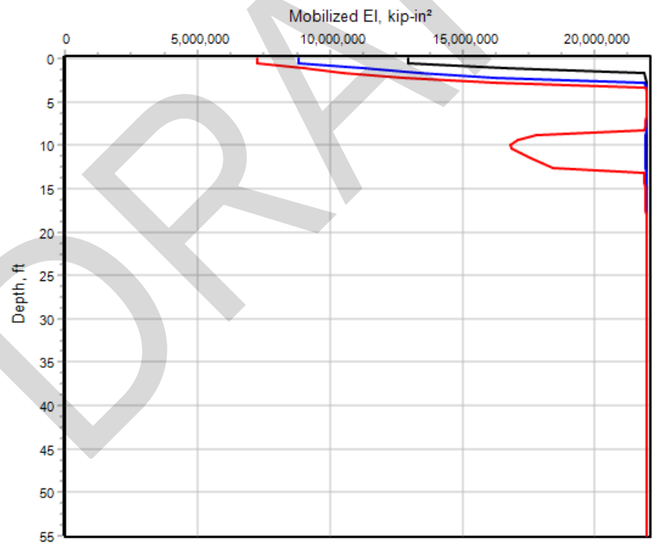
Figure 4

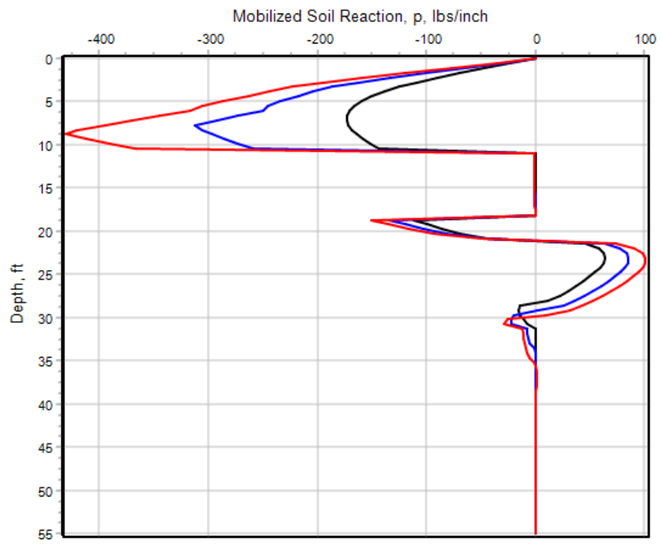












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4500 PSI

INDICATE FIXED PI
HEAD DEPTH BELO
GRADE

Assumptions

- 1.5-foot diameter Round Concrete Shaft (Bored Pile)
- 4,000 psi Concrete with 1% Steel Reinforcement
- Fixed-head condition
- Horizontal ground surface
- Single shaft with no group effects or p-multipliers
- 270 Kip vertical load, 16, 25 and 32 Kip lateral loads

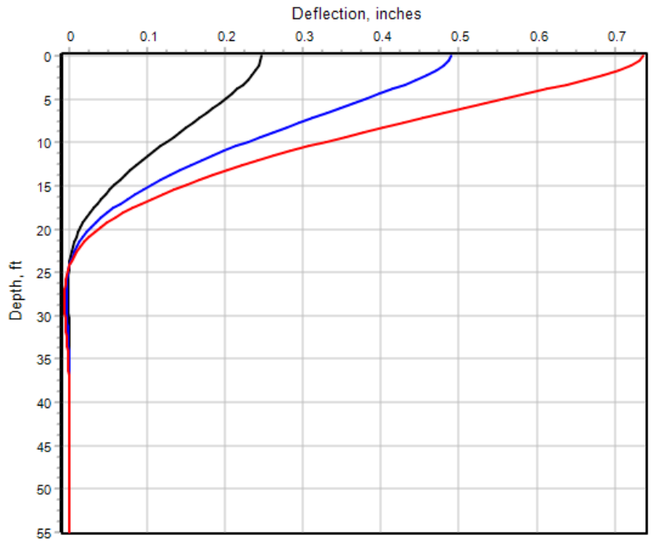
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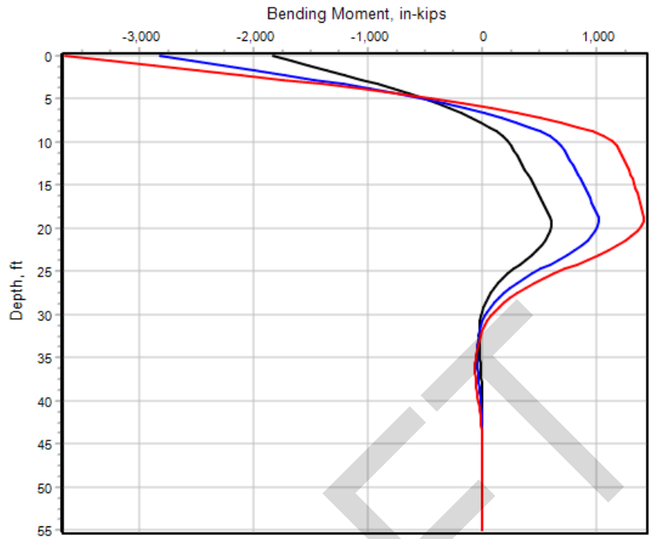
LPile Output Plots – 18-inch Diameter Shaft
Fixed Head – Odor Control Slab

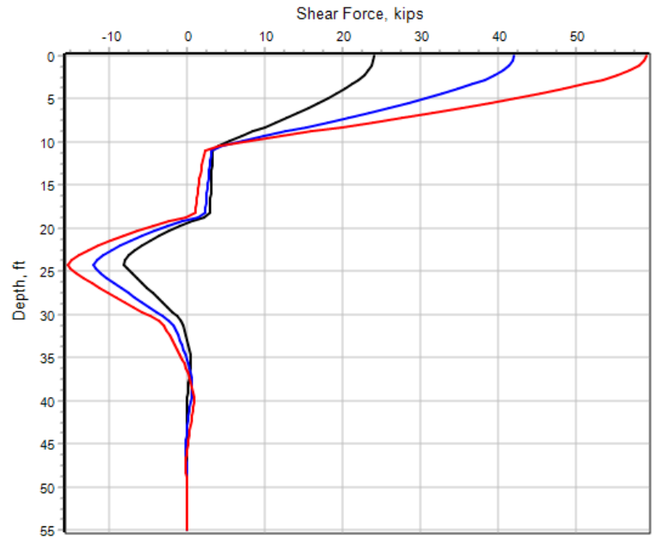
Post Point Sludge Tank Replacement
Bellingham, Washington

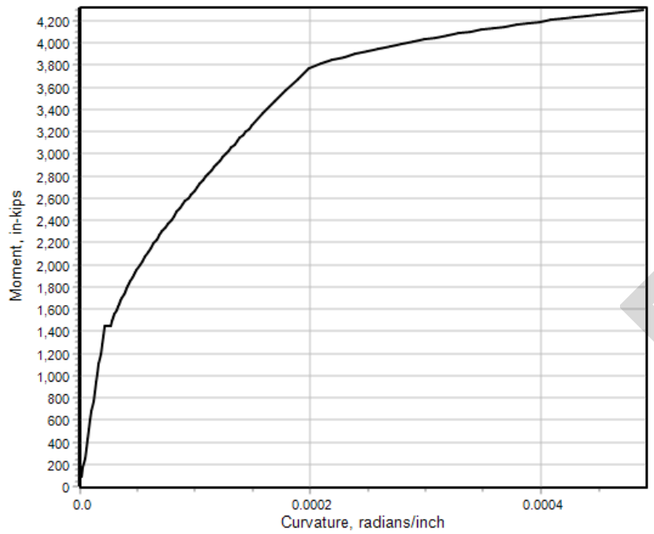
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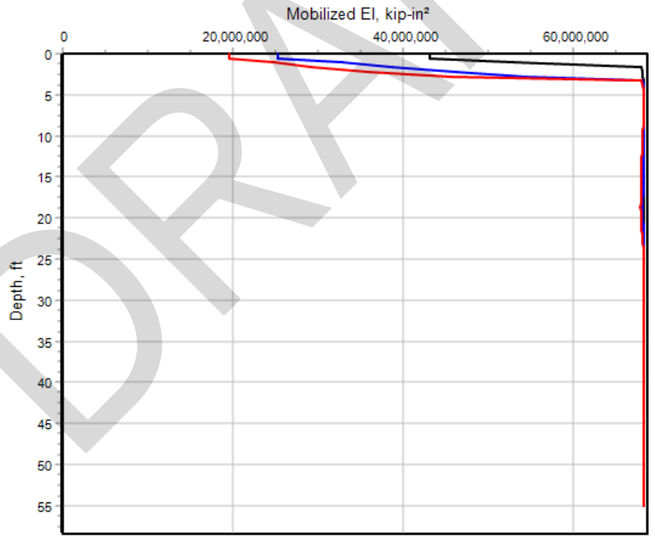
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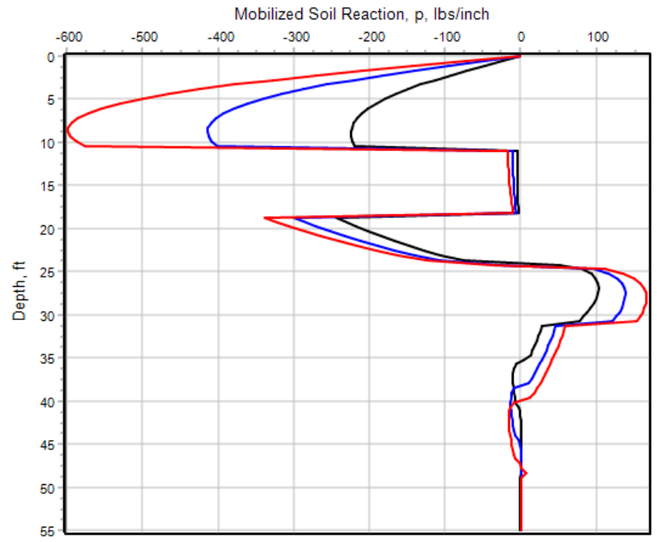












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4500 PSI

INDICATE FIXED P
HEAD DEPTH BEL
GRADE

Assumptions

- 2-foot diameter Round Concrete Shaft (Bored Pile)
- 4,000 psi Concrete with 1% Steel Reinforcement
- Fixed-head condition
- Horizontal ground surface
- Single shaft with no group effects or p-multipliers
- 270 Kip vertical load, 24, 42 and 59 Kip lateral loads

Reference: LPILE v2019.11.02 (Ensoft)

LPile Output Plots – 24-inch Diameter Shaft
Fixed Head – Odor Control Slab

Post Point Sludge Tank Replacement
Bellingham, Washington

GeoEngineers

Figure 6

Appendices

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Appendix A
Field Explorations and Laboratory Testing

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Appendix A
Field Explorations and Laboratory Testing

Subsurface soil and groundwater conditions at the site were evaluated by drilling two borings (B-1-23 and B-2-23). The borings were drilled to depths of 16½ and 61½ feet below the existing ground surface (bgs) and were completed on July 27, 2023, using a track-mounted drill rig subcontracted to GeoEngineers. The locations and elevations of the explorations were estimated in the field based on taping and pacing from relevant site features shown in a site survey drawing by Wilson Engineering. The approximate exploration locations are shown in the Site and Exploration Plan, Figure 2.

The soils encountered in the borings were generally sampled at 2½- or 5-foot vertical intervals with a 2-inch outside diameter split-barrel standard penetration test (SPT) sampler. Disturbed soil samples were obtained by driving the samplers 18 inches into the soil with a 140-pound rope and cathead hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions preclude driving the full 18-inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown on the boring logs at the respective sample depths.

The explorations were continuously monitored by a geotechnical scientist or geologist from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared a detailed log of each exploration. Soils encountered were classified visually in general accordance with ASTM International (ASTM) D-2488, which is described in Figure A-1. An explanation of our boring log symbols is also shown in Figure A-1.

The logs of the borings are presented in Figures A-2 through A-3. The exploration logs are based on our interpretation of the field and laboratory data and indicate the various types of soils encountered. They also indicate the depths at which these soils or their characteristics change, although the change might actually be gradual. If the change occurred between samples in the exploration, it was interpreted.

LABORATORY TESTING

Soil samples obtained from the explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of the determination of the moisture content, percent fines, sieve analysis, and Atterberg Limit determinations. The tests were performed in general accordance with test methods of the ASTM or other applicable procedures.

Moisture Content Testing

The natural moisture contents of selected soil samples obtained from the exploratory borings were estimated in general accordance with ASTM D 2216 test procedures. The results from the moisture content determinations are displayed shown on the exploration logs in Appendix A in the column labeled "Moisture Content (%)" adjacent to the corresponding samples.

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Percent Passing U.S. No. 200 Sieve

Selected samples were "washed" through the U.S. No. 200 mesh sieve to determine the relative percentage of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted in general accordance with ASTM D 1140. The results from the percent fines determinations are displayed in the column labeled "Fines Content (%)" adjacent to the corresponding samples on the summary exploration logs.

Sieve Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 6913 to determine the sample grain size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted, classified in general accordance with the Unified Soil Classification System (USCS), and are presented in Figure A-4.

Atterberg Limits Testing

Atterberg limit tests were performed on selected soil samples. The tests were used to classify the soil as well as to aid in estimating index properties and consolidation characteristics of the fine-grained soil deposits. The liquid limit and the plastic limit were estimated through a procedure in general accordance with ASTM D 4318. The results of the Atterberg limits testing are summarized in Figure A-5 and on the attached boring logs at their respective sample depths.

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SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel / Dames & Moore (D&M)

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point lead test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

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Key to Exploration Logs

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Figure A-1

elevations

Drilled Start 7/27/2023 End 7/27/2023	Total Depth (ft) 16.5	Logged By KLL Checked By AJH	Driller Boretec, Inc.	Drilling Method Hollow-stem Auger	
Surface Elevation (ft) Vertical Datum	Undetermined NAVD88	Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	EC 95 Track Drill
Latitude Longitude	48.7180961 -122.5138228	System Datum	Decimal Degrees WGS84	Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0					1		SM	Brown silty fine to medium sand with occasional gravel and occasional cobbles (loose, moist) (fill)			
			16	14		2 %F		SP-SM	Gray medium to coarse sand with silt (medium dense, moist)	18	12	
	5		4	28		3						
			17	10		4 SA		SM	Gray silty fine to medium sand with gravel (medium dense, moist)	10	26	
	10		4	14		5			With shell fragments			
			16	13		6 %F		SM	Gray silty fine to medium sand with gravel and occasional black organic matter (medium dense, moist)	20	22	
	15		1	50/4"		7						Blow counts overstated on gravel

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Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Boring B-1-23

GeoEngineers

Project: Post Point Primary Sludge Tank Replacement
Project Location: Bellingham, Washington
Project Number: 0356-185-00

Figure A-2
Sheet 1 of 1

Date:2/6/24 Path:\\GEOENGINEERS.COM\WAN\PROJECTS\0\0356185\GINT\0356185500.GPJ DBLibrary/Library/GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIB_GEOTECH_STANDARD_%F_NO_GW

Drilled Start 7/27/2023 End 7/27/2023	Total Depth (ft) 61.5	Logged By KLL Checked By AJH	Driller Boretec, Inc.	Drilling Method Hollow-stem Auger	
Surface Elevation (ft) Undetermined Vertical Datum NAVD88		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment EC 95 Track Drill	
Latitude 48.718216 Longitude -122.5138369		System Datum Decimal Degrees WGS84		See "Remarks" section for groundwater observed	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0			1			SM	Brown silty fine to medium sand with gravel and occasional cobbles (loose, moist) (fill)			
		16	16	2	SA		SM	Dark brown silty fine to coarse sand with gravel and occasional iron-staining; 1-inch lenses of gray clayey sandy silt (medium dense, moist)	10	19	
	5	12	18	3	MC				9		
		18	24	4	MC		SM	Gray silty fine to coarse sand with gravel (medium dense, moist)	11		dashed
	10	10	24	5	MC				11		
		18	9	6	%F			Becomes loose	12	24	
	15	18	6	7	MC		SM	Gray silty fine to medium sand with shell fragments (loose, moist) (beach deposits)	21		solid
	20	18	16	8	MC		CL	Gray clay (very stiff, moist) (glaciomarine drift)	29		
	25	18	10	9	MC			Becomes stiff, wet	24		Groundwater observed at approximately 25 feet below ground surface during drilling
	30	18	8	10	AL				33		AL (LL = 46; PI = 26)
	35										

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Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Boring B-2-23

GeoEngineers

Project: Post Point Primary Sludge Tank Replacement
Project Location: Bellingham, Washington
Project Number: 0356-185-00

Figure A-3
Sheet 1 of 2

Date:2/6/24 Path:\\GEOENGINEERS.COM\WAN\PROJECTS\0\0356185\GINT\0356185500.GPJ DBLibrary:Library\GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIB_GEOTECH_STANDARD_%F_NO_GW

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	FIELD DATA: Blows/foot	FIELD DATA: Collected Sample	FIELD DATA: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35	18	3		11 AL			Becomes soft	24		AL (LL = 25; PI = 17)
	40	18	11		12 MC		CL	Gray silty clay with sand (stiff, wet)	20		
	45	18	20		13 MC				22		
	50	18	49		14 %F		SM	Gray silty sand (dense, wet) (glacially consolidated soils)	17	21	
	55	18	67		15 %F		GP-GM	Gray fine to coarse gravel with sand and silt (very dense, wet)	11	9	
							SP-SM	Gray medium to coarse sand with silt (very dense, wet)			
	60	18	83		16 %F				13	11	

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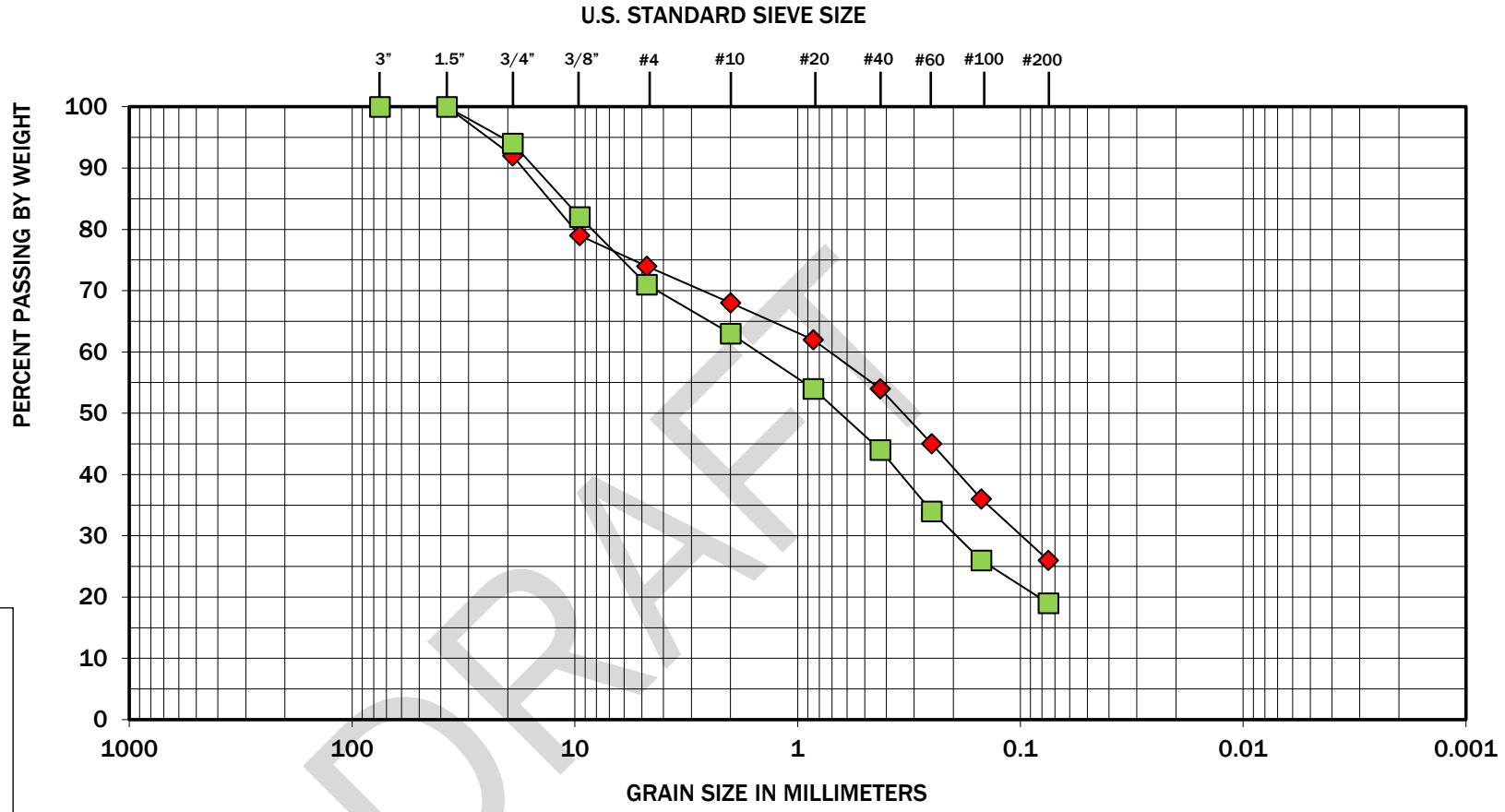
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Log of Boring B-2-23 (continued)

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Project: Post Point Primary Sludge Tank Replacement
Project Location: Bellingham, Washington
Project Number: 0356-185-00

Figure A-3
Sheet 2 of 2



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COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	B-1-23	7.5	10	Silty sand with gravel (SM)
■	B-2-23	2.5	10	Silty sand with gravel (SM)

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The grain size analysis results were obtained in general accordance with ASTM D 6913. GeoEngineers 17425 NE Union Hill Road Ste 250, Redmond, WA 98052

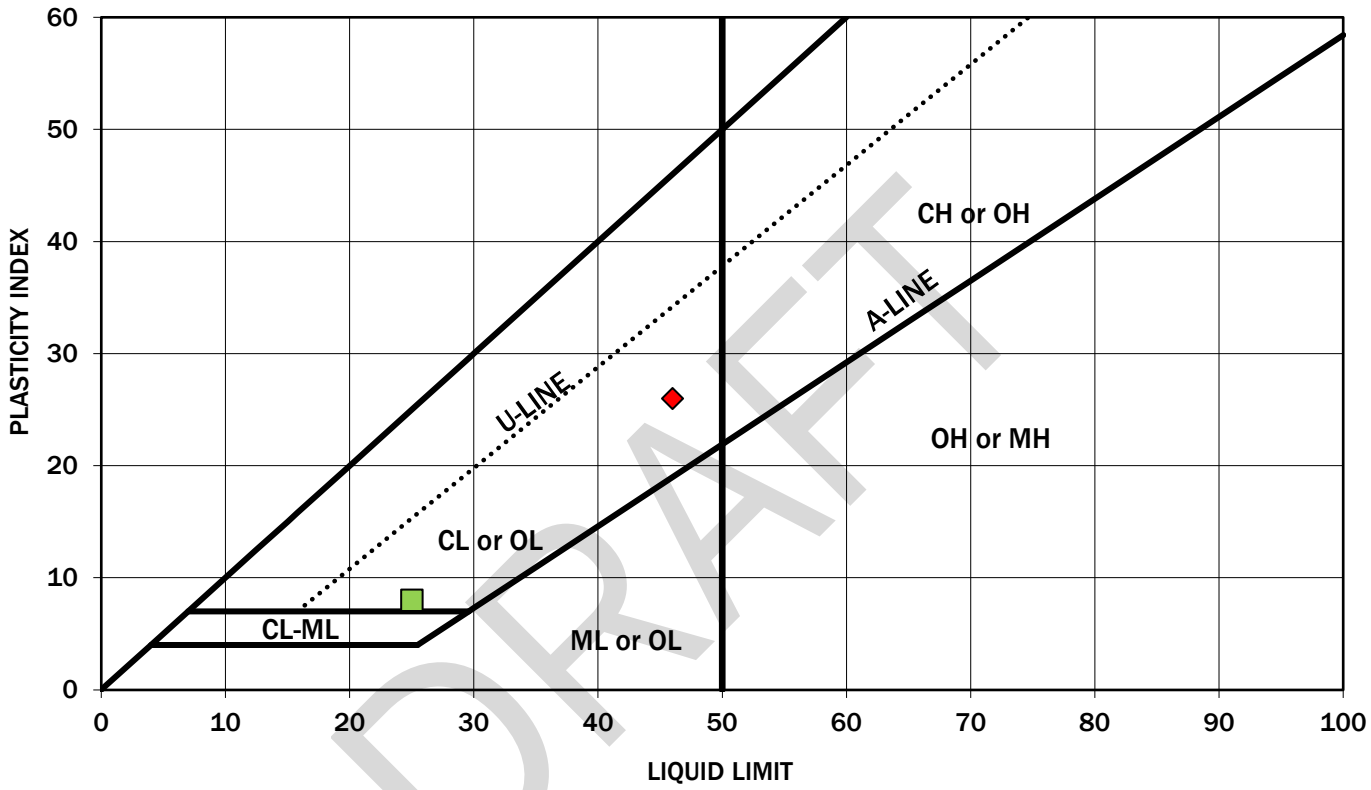
Sieve Analysis Results

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

GeoEngineers

Figure A-4

PLASTICITY CHART



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Symbol	Boring Number	Depth (feet)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Soil Description
◆	B-2-23	30	33	46	26	Clay (CL)
■	B-2-23	35	24	25	17	Clay (CL)

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Atterberg Limits Test Results

Post Point Primary Sludge Tank Replacement
Bellingham, Washington

GeoEngineers

Figure A-5

0356-185-00 Date Exported: 08/09/2023

Appendix B
Outside Laboratory Testing

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Appendix B
Outside Laboratory Testing

Corrosion potential of selected soil samples was conducted based on laboratory chemical testing subcontracted to Norton Corrosion of Woodinville, Washington. Laboratory testing included pH, chloride, sulfate, sulfide, redox potential, and resistivity, the results of which are summarized in Table 6 in the report. Test results are also presented on the following summary page.

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NORTON CORROSION LIMITED

CORROSION EVALUATION
DUCTILE IRON PIPE

DATA SHEET: 1 OF 1
NCL JOB #: E-24432
DATE IN: 29 JAN 2024
DATE OUT: 09 FEB 2024
BY: H. DUFFY

SOIL ANALYSIS

STOMER: Geo Engineers
ROJECT: Post Point Sludge Tank
JOB #: 0356.185-00

NCL SAMPLE NO.	SAMPLE I.D.	Soil Wt. Native	Soil Wt. Dry	% MOISTURE	pH	SULFIDE SCREEN (ppm)	RESISTIVITY (Ω-CM) NATIVE	RESISTIVITY (Ω-CM) SATURATED	REDOX (mV)	DIPRA SCORE	CHLORIDE (ppm)	SULFATE (mg/L)
1	B-1 S-2 2.5'	27.857	25.991	6.70	5.9	ND*	8,700	3,800	104.2	0	93	32
2	B-1 S-4 7.5'	25.070	24.070	3.99	7.0	ND*	43,000	7,100	151.2	0	<30	33
3	B-2 S-2 2.5'	25.821	24.615	4.67	6.6	ND*	73,000	15,000	140.5	0	<30	IS**
4	B-2 S-4 7.5'	29.355	26.727	8.95	6.9	ND*	9,800	5,000	173.2	0	<30	<2
5												
6												
TESTING METHOD					ASTM 4972	EPA 9030B	ASTM G-57	ASTM G-57	ASTM D1498		EPA 300.0	EPA 300.0

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ND* Analyte NOT DETECTED at or above the reporting limit
IS** Insufficient sample to run test

Appendix C
Report Limitations and Guidelines for Use

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Appendix C
Report Limitations And Guidelines For Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for Carollo Engineers, Inc., the City of Bellingham, and for the Project(s) specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our Agreement with Carollo Engineers, Inc. authorized by Susanna Leung on July 12, 2023, and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the proposed Post Point Sludge Tank Replacement Project to be located in Bellingham, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

[1]Developed based on material provided by GBA, GeoProfessional Business Association; www.geoprofessional.org.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers

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cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to conduct additional study to obtain the specific types of information they need or prefer.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

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BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

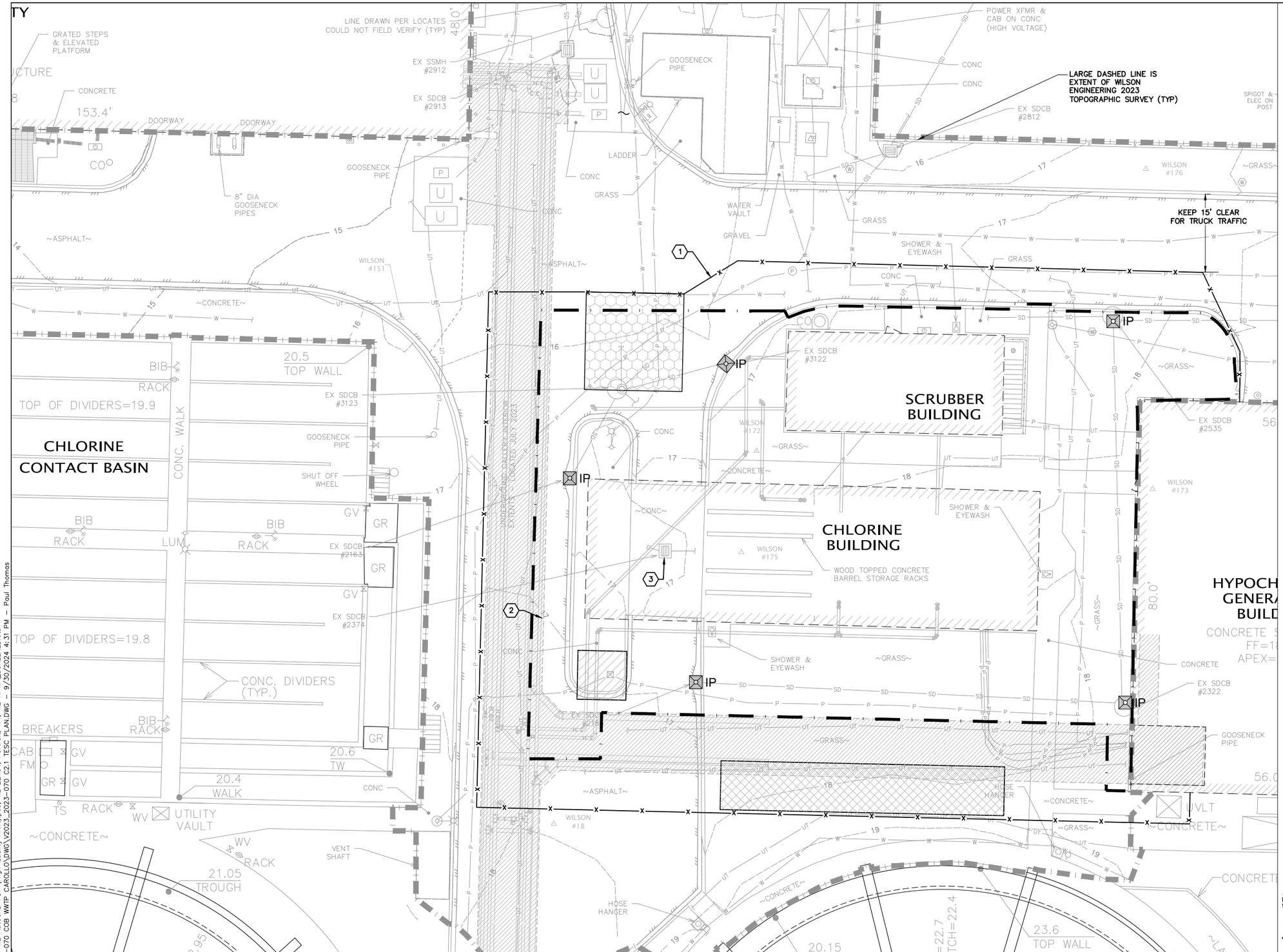
INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

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APPENDIX C – TESC Plans



TESC LEGEND

- IP = INLET PROTECTION PER 3 / 020C106
- x = TEMPORARY 6' CHAINLINK FENCE
- = CONSTRUCTION ENTRANCE PER 1 / 020C106
- = CONCRETE WASHOUT AND CONTAINMENT
- = STAGING AREA
- = LIMITS OF DISTURBANCE

KEYED NOTES

1. PROJECT BOUNDARY, INSTALL TEMPORARY 6" CHAINLINK FENCE
2. PROTECT EXISTING UTILITY GALLERY DURING DEMOLITION
3. ABANDON EXIST CATCH BASIN IN PLACE AND PLUG PIPES. USE CDF AS NEEDED.

SCALE 10 0 10 20 FEET
HORIZONTAL SCALE

811 Call 811 two business days before you dig

PRELIMINARY — PAUL M. THOMAS — STATE OF WASHINGTON — 17120 — REGISTERED PROFESSIONAL ENGINEER

WILSON ENGINEERING

Date	No	Revision	By
	4		
	3	INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION	
	2		
	1		

PROJECT ENGINEER PMT
DESIGNED/DRAWN PMT
INSPECTOR MFM

DIRECTOR PUBLIC WORKS
CITY ENGINEER
ASSISTANT DIRECTOR

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. As Shown
Vert. As Shown

DATUM
H: NAD 83/98
V: NAVD 88

Job. No. 2023-070
Date 10/07/2024
Field Bk.

POST POINT RESOURCE RECOVERY PLANT
TEMPORARY EROSION AND SEDIMENT CONTROL PLAN

DRAWING NO. 020C104
SHEET NO.

PLOT SETTINGS: WE AutoCAD PDF (High Quality Print).pc3, WE 22X34, Portrait, 1:1, WE APWA_SCREENED.ctb
W:\2023\2023-070 COB WWTP CAROLLO\DWG\V2023_2023-070 C2.1 TESC PLAN.DWG – 9/30/2024 4:31 PM – Paul Thomas

CONTACT PERSON: STEPHEN DAY, P.E., S.E. , PROJECT ENGINEER AT (360) 778-7922

CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (SWPPP)
PER BELLINGHAM MUNICIPAL CODE 15.42.060 F. 2. E.

ELEMENTS OF CONSTRUCTION STORMWATER POLLUTION PREVENTION.

I. ELEMENT 1 – PRESERVE VEGETATION/MARK CLEARING LIMITS. PRIOR TO BEGINNING LAND–DISTURBING ACTIVITIES, INCLUDING CLEARING AND GRADING, ALL CLEARING LIMITS, SENSITIVE AREAS AND THEIR BUFFERS, AND TREES THAT ARE TO BE PRESERVED WITHIN THE CONSTRUCTION AREA SHOULD BE CLEARLY MARKED, BOTH IN THE FIELD AND ON THE PLANS, TO PREVENT DAMAGE AND OFF–SITE IMPACTS. PLASTIC, METAL, OR STAKE WIRE FENCE MAY BE USED TO MARK THE CLEARING LIMITS. RETAIN THE DUFF LAYER, NATIVE TOP SOIL, AND NATURAL VEGETATION IN AN UNDISTURBED STATE TO THE MAXIMUM DEGREE PRACTICABLE.

II. ELEMENT 2 – ESTABLISH CONSTRUCTION ACCESS.

(A) CONSTRUCTION VEHICLE ACCESS AND EXIT SHALL BE LIMITED TO ONE ROUTE IF POSSIBLE.

(B) ACCESS POINTS SHALL BE STABILIZED WITH QUARRY SPALL OR CRUSHED ROCK TO MINIMIZE THE TRACKING OF SEDIMENT ONTO PUBLIC ROADS.

(C) WHEEL WASH OR TIRE BATHS SHOULD BE LOCATED ON SITE, IF APPLICABLE.

(D) PUBLIC ROADS SHALL AT A MINIMUM BE CLEANED THOROUGHLY AT THE END OF EACH DAY. SEDIMENT SHALL BE REMOVED FROM ROADS BY SHOVELING OR PICKUP SWEEPING AND SHALL BE TRANSPORTED TO A CONTROLLED SEDIMENT DISPOSAL AREA. STREET WASHING WILL BE ALLOWED ONLY AFTER SEDIMENT IS REMOVED IN THIS MANNER.

(E) STREET WASH WASTEWATER SHALL BE CONTROLLED BY PUMPING BACK ON SITE, OR OTHERWISE BE PREVENTED FROM DISCHARGING INTO SYSTEMS TRIBUTARY TO STATE SURFACE WATERS.

(F) CONTROL STREET WASH WASTEWATER BY PUMPING BACK ON SITE, OR OTHERWISE PREVENT IT FROM DISCHARGING INTO SYSTEMS TRIBUTARY TO WATERS OF THE STATE.

III. ELEMENT 3 – CONTROL FLOW RATES.

(A) PROTECT PROPERTIES AND WATERWAYS DOWNSTREAM OF DEVELOPMENT SITES FROM EROSION AND THE ASSOCIATED DISCHARGE OF TURBID WATERS DUE TO INCREASES IN THE VELOCITY AND PEAK VOLUMETRIC FLOW RATE OF STORMWATER RUNOFF FROM THE PROJECT SITE.

(B) PROPERTIES SUBJECT TO MINIMUM REQUIREMENT NO. 5 AND/OR NO. 7 SHALL IMPLEMENT CONTROLS AS EARLY IN THE DEVELOPMENT AS IS PRACTICABLE TO MITIGATE FOR FLOW RATES.

(C) WHERE NECESSARY TO COMPLY WITH MINIMUM REQUIREMENT NO. 7, STORMWATER RETENTION/DETENTION FACILITIES SHALL BE CONSTRUCTED AS ONE OF THE FIRST STEPS IN GRADING. DETENTION FACILITIES SHALL BE FUNCTIONAL PRIOR TO CONSTRUCTION OF SITE IMPROVEMENTS (E.G., IMPERVIOUS SURFACES).

(D) IF PERMANENT INFILTRATION PONDS ARE USED FOR FLOW CONTROL DURING CONSTRUCTION, THESE FACILITIES SHOULD BE PROTECTED FROM SILTATION DURING THE CONSTRUCTION PHASE.

IV. ELEMENT 4 – INSTALL SEDIMENT CONTROLS.

(A) DESIGN, INSTALL, AND MAINTAIN EFFECTIVE EROSION CONTROLS AND SEDIMENT CONTROLS TO MINIMIZE THE DISCHARGE OF POLLUTANTS.

(B) CONSTRUCT SEDIMENT CONTROL BMPS (SEDIMENT PONDS, TRAPS, FILTERS, ETC.) AS ONE OF THE FIRST STEPS IN GRADING. THESE BMPS SHALL BE FUNCTIONAL BEFORE OTHER LAND–DISTURBING ACTIVITIES TAKE PLACE.

(C) MINIMIZE SEDIMENT DISCHARGES FROM THE SITE. THE DESIGN, INSTALLATION AND MAINTENANCE OF EROSION AND SEDIMENT CONTROLS MUST ADDRESS FACTORS SUCH AS THE AMOUNT, FREQUENCY, INTENSITY AND DURATION OF PRECIPITATION, THE NATURE OF RESULTING STORMWATER RUNOFF, AND SOIL CHARACTERISTICS, INCLUDING THE RANGE OF SOIL PARTICLE SIZES EXPECTED TO BE PRESENT ON THE SITE.

(D) DIRECT STORMWATER RUNOFF FROM DISTURBED AREAS THROUGH A SEDIMENT POND OR OTHER APPROPRIATE SEDIMENT REMOVAL BMP, BEFORE THE RUNOFF LEAVES A CONSTRUCTION SITE OR BEFORE DISCHARGE TO AN INFILTRATION FACILITY. RUNOFF FROM FULLY STABILIZED AREAS MAY BE DISCHARGED WITHOUT A SEDIMENT REMOVAL BMP, BUT MUST MEET THE FLOW CONTROL PERFORMANCE STANDARD IN SUBSECTION (F)(2)(E)(III)(A) OF THIS SECTION.

(E) LOCATE BMPS INTENDED TO TRAP SEDIMENT ON SITE IN A MANNER TO AVOID INTERFERENCE WITH THE MOVEMENT OF JUVENILE SALMONIDS ATTEMPTING TO ENTER OFF–CHANNEL AREAS OR DRAINAGES.

(F) WHERE FEASIBLE, DESIGN OUTLET STRUCTURES THAT WITHDRAW IMPOUNDED STORMWATER FROM THE SURFACE TO AVOID DISCHARGING SEDIMENT THAT IS STILL SUSPENDED LOWER IN THE WATER COLUMN.

V. ELEMENT 5 – STABILIZE SOILS.

(A) ALL EXPOSED AND UNWORKED SOILS SHALL BE STABILIZED BY APPLICATION OF EFFECTIVE BMPS THAT PROTECT THE SOIL FROM THE EROSIVE FORCES OF RAINDROP IMPACT AND FLOWING WATER, AND WIND EROSION. APPLICABLE BMPS INCLUDE, BUT ARE NOT LIMITED TO: TEMPORARY AND PERMANENT SEEDING, SODDING, MULCHING, PLASTIC COVERING, EROSION CONTROL FABRICS AND MATTING, SOIL APPLICATION OF POLYACRYLAMIDE (PAM), THE EARLY APPLICATION OF GRAVEL BASE EARLY ON AREAS TO BE PAVED, AND DUST CONTROL.

(B) CONTROL STORMWATER VOLUME AND VELOCITY WITHIN THE SITE TO MINIMIZE SOIL EROSION.

(C) CONTROL STORMWATER DISCHARGES, INCLUDING BOTH PEAK FLOW RATES AND TOTAL STORMWATER VOLUME, TO MINIMIZE EROSION AT OUTLETS AND TO MINIMIZE DOWNSTREAM CHANNEL AND STREAM BANK EROSION.

(D) FROM OCTOBER 1ST THROUGH APRIL 30TH OF EACH YEAR, NO SOILS SHALL REMAIN EXPOSED AND UNWORKED FOR MORE THAN TWO DAYS. FROM MAY 1ST TO SEPTEMBER 30TH OF EACH YEAR, NO SOILS SHALL REMAIN EXPOSED AND UNWORKED FOR MORE THAN SEVEN DAYS. THIS CONDITION APPLIES TO ALL SOILS ON SITE, WHETHER AT FINAL GRADE OR NOT.

(E) STABILIZE SOILS AT THE END OF THE SHIFT BEFORE A HOLIDAY OR WEEKEND IF NEEDED BASED ON THE WEATHER FORECAST.

(F) MINIMIZE THE AMOUNT OF SOIL EXPOSED DURING CONSTRUCTION ACTIVITY.

(G) MINIMIZE THE DISTURBANCE OF STEEP SLOPES.

(H) MINIMIZE SOIL COMPACTION AND, UNLESS INFEASIBLE, PRESERVE TOPSOIL.

(I) APPLICABLE PRACTICES INCLUDE, BUT ARE NOT LIMITED TO, TEMPORARY AND PERMANENT SEEDING, SODDING, MULCHING, PLASTIC COVERING, SOIL APPLICATION OF POLYACRYLAMIDE (PAM), EARLY APPLICATION OF GRAVEL BASE ON AREAS TO BE PAVED, AND DUST CONTROL.

(J) SOIL STABILIZATION MEASURES SELECTED SHOULD BE APPROPRIATE FOR THE TIME OF YEAR, SITE CONDITIONS, ESTIMATED DURATION OF USE, AND POTENTIAL WATER QUALITY IMPACTS THAT STABILIZATION AGENTS MAY HAVE ON DOWNSTREAM WATERS OR GROUND WATER.

(K) SOIL STOCKPILES MUST BE STABILIZED AND PROTECTED WITH SEDIMENT TRAPPING MEASURES AND, WHERE POSSIBLE, LOCATE AWAY FROM STORM DRAIN INLETS, WATERWAYS AND DRAINAGE CHANNELS.

(L) WORK ON LINEAR CONSTRUCTION SITES AND ACTIVITIES, INCLUDING RIGHT–OF–WAY AND EASEMENT CLEARING, ROADWAY DEVELOPMENT, PIPELINES, AND TRENCHING FOR UTILITIES, SHALL NOT EXCEED THE CAPABILITY OF THE INDIVIDUAL CONTRACTOR FOR HIS PORTION OF THE PROJECT TO INSTALL THE BEDDING MATERIALS, ROADBEDS, STRUCTURES, PIPELINES, AND/OR UTILITIES, AND TO RESTABILIZE THE DISTURBED SOILS, MEETING THE TIMING CONDITIONS LISTED ABOVE.

(M) IN ADDITION, AT THE DISCRETION OF THE PUBLIC WORKS DIRECTOR, THOSE SITES UNABLE TO MAINTAIN THE QUALITY OF THEIR STORMWATER DISCHARGE MAY BE REQUIRED TO PROVIDE SOIL STABILIZATION TO ALL EXPOSED SOIL AREAS REGARDLESS OF THE WORKING STATUS OF THE AREA. UPON WRITTEN NOTIFICATION, THE PROPERTY OWNER SHALL PROVIDE FULL STABILIZATION OF ALL EXPOSED SOIL AREAS WITHIN 24 HOURS.

VI. ELEMENT 6 – PROTECT SLOPES.

(A) CUT AND FILL SLOPES SHALL BE DESIGNED AND CONSTRUCTED IN A MANNER THAT WILL MINIMIZE EROSION. APPLICABLE PRACTICES INCLUDE, BUT ARE NOT LIMITED TO, REDUCING CONTINUOUS LENGTH OF SLOPE WITH TERRACING AND DIVERSIONS, REDUCING SLOPE STEEPNESS, AND ROUGHENING SLOPE SURFACES (FOR EXAMPLE, TRACK WALKING).

(B) CONSIDER SOIL TYPE AND ITS POTENTIAL FOR EROSION.

(C) REDUCE SLOPE RUNOFF VELOCITIES BY REDUCING THE CONTINUOUS LENGTH OF SLOPE WITH TERRACING AND DIVERSIONS, REDUCE SLOPE STEEPNESS, AND ROUGHEN SLOPE SURFACE.

(D) DIVERT UPSLOPE DRAINAGE AND RUN–ON WATERS FROM OFF SITE WITH INTERCEPTORS AT TOP OF SLOPE. OFF–SITE STORMWATER SHOULD BE HANDLED SEPARATELY FROM STORMWATER GENERATED ON THE SITE. DIVERSION OF OFF–SITE STORMWATER AROUND THE SITE MAY BE A VIABLE OPTION. DIVERTED FLOWS SHALL BE REDIRECTED TO THE NATURAL DRAINAGE LOCATION AT OR BEFORE THE PROPERTY BOUNDARY.

(E) CONTAIN DOWN SLOPE COLLECTED FLOWS IN PIPES, SLOPE DRAINS, OR PROTECTED CHANNELS TO PREVENT EROSION. TEMPORARY PIPE SLOPE DRAINS MUST HANDLE THE PEAK VOLUMETRIC FLOW RATE CALCULATED USING A 10–MINUTE TIME STEP FROM A TYPE 1A, 10–YEAR, 24–HOUR FREQUENCY STORM FOR THE DEVELOPED CONDITION. ALTERNATIVELY, THE 10–YEAR ONE–HOUR FLOW RATE PREDICTED BY AN APPROVED CONTINUOUS RUNOFF MODEL, INCREASED BY A FACTOR OF 1.6, MAY BE USED. THE HYDROLOGIC ANALYSIS MUST USE THE EXISTING LAND COVER CONDITION FOR PREDICTING FLOW RATES FROM TRIBUTARY AREAS OUTSIDE THE PROJECT LIMITS. FOR TRIBUTARY AREAS ON THE PROJECT SITE, THE ANALYSIS MUST USE THE TEMPORARY OR PERMANENT PROJECT LAND COVER CONDITION, WHICHEVER WILL PRODUCE THE HIGHEST FLOW RATES. IF USING THE WESTERN WASHINGTON HYDROLOGY MODEL TO PREDICT FLOWS, BARE SOIL AREAS SHOULD BE MODELED AS "LANDSCAPED AREA."

(F) PROVIDE DRAINAGE TO REMOVE GROUND WATER INTERSECTING THE SLOPE SURFACE OF EXPOSED SOIL AREAS.

(G) EXCAVATED MATERIAL SHALL BE PLACED ON THE UPHILL SIDE OF TRENCHES, CONSISTENT WITH SAFETY AND SPACE CONSIDERATIONS.

(H) CHECK DAMS SHALL BE PLACED AT REGULAR INTERVALS WITHIN TRENCHES THAT ARE CUT DOWN A SLOPE.

(I) STABILIZE SOILS ON SLOPES, AS SPECIFIED IN ELEMENT NO. 5.

VII. ELEMENT 7 – PROTECT DRAIN INLETS.

(A) ALL STORM DRAIN INLETS MADE OPERABLE DURING CONSTRUCTION SHALL BE PROTECTED SO THAT STORMWATER RUNOFF SHALL NOT ENTER THE CONVEYANCE SYSTEM WITHOUT FIRST BEING FILTERED OR TREATED TO REMOVE SEDIMENT.

(B) ALL APPROACH ROADS SHALL BE KEPT CLEAN, AND ALL SEDIMENT AND STREET WASH WATER SHALL NOT BE ALLOWED TO ENTER STORM DRAINS WITHOUT PRIOR AND ADEQUATE TREATMENT UNLESS TREATMENT IS PROVIDED BEFORE THE STORM DRAIN DISCHARGES TO WATERS OF THE STATE.

VIII. ELEMENT 8 – STABILIZE CHANNELS AND OUTLETS.

(A) ALL TEMPORARY ON–SITE CONVEYANCE CHANNELS SHALL BE DESIGNED, CONSTRUCTED AND STABILIZED TO PREVENT EROSION FROM EXPECTED PEAK FLOWS. CHANNELS MUST HANDLE THE PEAK VOLUMETRIC FLOW RATE CALCULATED USING A 10–MINUTE TIME STEP FROM A TYPE 1A, 10–YEAR, 24–HOUR FREQUENCY STORM FOR THE DEVELOPED CONDITION. ALTERNATIVELY, THE 10–YEAR PEAK FLOW RATE, AS DETERMINED BY AN APPROVED CONTINUOUS RUNOFF MODEL WITH A 15–MINUTE TIME STEP, MAY BE USED. THE HYDROLOGIC ANALYSIS MUST USE THE EXISTING LAND COVER CONDITION FOR PREDICTING FLOW RATES FROM TRIBUTARY AREAS OUTSIDE THE PROJECT LIMITS. FOR TRIBUTARY AREAS ON THE PROJECT SITE, THE ANALYSIS SHALL USE THE TEMPORARY OR PERMANENT PROJECT LAND COVER CONDITION, WHICHEVER WILL PRODUCE THE HIGHEST FLOW RATES. IF USING THE WESTERN WASHINGTON HYDROLOGY MODEL TO PREDICT FLOWS, BARE SOIL AREAS SHOULD BE MODELED AS "LANDSCAPED AREA."

(B) STABILIZATION, INCLUDING ARMORING MATERIAL, ADEQUATE TO PREVENT EROSION OF OUTLETS, ADJACENT STREAM BANKS, SLOPES AND DOWNSTREAM REACHES SHALL BE PROVIDED AT THE OUTLETS OF ALL CONVEYANCE SYSTEMS.

IX. ELEMENT 9 – CONTROL POLLUTANTS.

(A) DESIGN, INSTALL, IMPLEMENT AND MAINTAIN EFFECTIVE POLLUTION PREVENTION MEASURES TO MINIMIZE THE DISCHARGE OF POLLUTANTS.

(B) ALL POLLUTANTS, INCLUDING WASTE MATERIALS AND DEMOLITION DEBRIS, THAT OCCUR ON SITE DURING CONSTRUCTION SHALL BE HANDLED AND DISPOSED OF IN A MANNER THAT DOES NOT CAUSE CONTAMINATION OF STORMWATER.

(C) COVER, CONTAINMENT, AND PROTECTION FROM VANDALISM SHALL BE PROVIDED FOR ALL CHEMICALS, LIQUID PRODUCTS, PETROLEUM PRODUCTS, AND NONINERT WASTES PRESENT ON THE SITE (SEE CHAPTER 173–304 WAC, AS CURRENTLY ENACTED OR HEREAFTER MODIFIED, FOR THE DEFINITION OF INERT WASTE, WHICH IS INCORPORATED HEREIN BY THIS REFERENCE).

(D) MAINTENANCE AND REPAIR OF HEAVY EQUIPMENT AND VEHICLES INVOLVING OIL CHANGES, HYDRAULIC SYSTEM DRAIN DOWN, SOLVENT AND DE–GREASING CLEANING OPERATIONS, FUEL TANK DRAIN DOWN AND REMOVAL, AND OTHER ACTIVITIES WHICH MAY RESULT IN DISCHARGE OR SPILLAGE OF POLLUTANTS TO THE GROUND OR INTO STORMWATER RUNOFF MUST BE CONDUCTED USING SPILL PREVENTION MEASURES, SUCH AS DRIP PANS. CONTAMINATED SURFACES SHALL BE CLEANED IMMEDIATELY FOLLOWING ANY DISCHARGE OR SPILL INCIDENT. EMERGENCY REPAIRS MAY BE PERFORMED ON SITE USING TEMPORARY PLASTIC PLACED BENEATH AND, IF RAINING, OVER THE VEHICLE.

(E) WHEEL WASH, OR TIRE BATH WASTEWATER, SHALL BE DISCHARGED TO A SEPARATE ON–SITE TREATMENT SYSTEM OR TO THE SANITARY SEWER.

(F) APPLICATION OF AGRICULTURAL CHEMICALS, INCLUDING FERTILIZERS AND PESTICIDES, SHALL BE CONDUCTED IN A MANNER AND AT APPLICATION RATES THAT WILL NOT RESULT IN LOSS OF CHEMICAL TO STORMWATER RUNOFF. MANUFACTURERS' RECOMMENDATIONS SHALL BE FOLLOWED FOR APPLICATION RATES AND PROCEDURES.

(G) MANAGEMENT OF PH–MODIFYING SOURCES SHALL PREVENT CONTAMINATION OF RUNOFF AND STORMWATER COLLECTED ON THE SITE. THESE SOURCES INCLUDE, BUT ARE NOT LIMITED TO, BULK CEMENT, CEMENT KILN DUST, FLY ASH, NEW CONCRETE WASHING AND CURING WATERS, WASTE STREAMS GENERATED FROM CONCRETE GRINDING AND SAWING, EXPOSED AGGREGATE PROCESSES, AND CONCRETE PUMPING AND MIXER WASHOUT WATERS.

(H) ADJUST THE PH OF STORMWATER IF NECESSARY TO PREVENT VIOLATIONS OF WATER QUALITY STANDARDS.

(I) ASSURE THAT WASHOUT OF CONCRETE TRUCKS IS PERFORMED OFF SITE OR IN DESIGNATED CONCRETE WASHOUT AREAS ONLY. DO NOT WASH OUT CONCRETE TRUCKS ONTO THE GROUND, OR INTO STORM DRAINS, OPEN DITCHES, STREETS, OR STREAMS. DO NOT DUMP EXCESS CONCRETE ON SITE, EXCEPT IN DESIGNATED CONCRETE WASHOUT AREAS. CONCRETE SPILLAGE OR CONCRETE DISCHARGE TO SURFACE WATERS OF THE STATE IS PROHIBITED. DO NOT WASH OUT TO FORMED AREAS AWAITING INFILTRATION BMPS.

(J) OBTAIN WRITTEN APPROVAL FROM ECOLOGY BEFORE USING CHEMICAL TREATMENT OTHER THAN CO2, DRY ICE, OR FOOD GRADE VINEGAR TO ADJUST PH.

(K) UNCONTAMINATED WATER FROM WATER–ONLY BASED SHAFT DRILLING FOR CONSTRUCTION OF BUILDING, ROAD, AND BRIDGE FOUNDATIONS MAY BE INFILTRATED PROVIDED THE WASTEWATER IS MANAGED IN A WAY THAT PROHIBITS DISCHARGE TO SURFACE WATERS. PRIOR TO INFILTRATION, WATER FROM WATER–ONLY BASED SHAFT DRILLING THAT COMES INTO CONTACT WITH CURING CONCRETE MUST BE NEUTRALIZED UNTIL PH IS IN THE RANGE OF 6.5 TO 8.5 (SU).

X. ELEMENT 10 – CONTROL DEWATERING.

(A) ALL FOUNDATION, VAULT, AND TRENCH DEWATERING WATER, WHICH HAVE SIMILAR CHARACTERISTICS TO STORMWATER RUNOFF AT THE SITE, SHALL BE DISCHARGED INTO A CONTROLLED CONVEYANCE SYSTEM, PRIOR TO DISCHARGE TO A SEDIMENT TRAP OR SEDIMENT POND. CHANNELS MUST BE STABILIZED, AS SPECIFIED IN ELEMENT NO. 8.

(B) CLEAN, NONTURBID DEWATERING WATER, SUCH AS WELL–POINT GROUND WATER, CAN BE DISCHARGED TO SYSTEMS TRIBUTARY TO STATE SURFACE WATERS, AS SPECIFIED IN ELEMENT NO. 8, PROVIDED THE DEWATERING FLOW DOES NOT CAUSE EROSION OR FLOODING OF THE RECEIVING WATERS. THESE CLEAN WATERS SHOULD NOT BE ROUTED THROUGH SEDIMENT PONDS WITH STORMWATER.

(C) HIGHLY TURBID OR OTHERWISE CONTAMINATED DEWATERING WATER, SUCH AS FROM CONSTRUCTION EQUIPMENT OPERATION, CLAMSHELL DIGGING, CONCRETE TREMIE POUR, OR WORK INSIDE A COFFERDAM, SHALL BE HANDLED SEPARATELY FROM STORMWATER AT THE SITE.

(D) OTHER DISPOSAL OPTIONS, DEPENDING ON SITE CONSTRAINTS, MAY INCLUDE, BY WAY OF EXAMPLE: (1) INFILTRATION, (2) TRANSPORT OFF SITE IN VEHICLE, SUCH AS A VACUUM FLUSH TRUCK, FOR LEGAL DISPOSAL IN A MANNER THAT DOES NOT POLLUTE STATE WATERS, (3) ON–SITE TREATMENT USING ECOLOGY APPROVED CHEMICAL TREATMENT OR OTHER SUITABLE TREATMENT TECHNOLOGIES, (4) SANITARY OR COMBINED SEWER DISCHARGE WITH LOCAL SEWER DISTRICT APPROVAL, OR IF THERE IS NO OTHER OPTION, (5) USE OF A SEDIMENTATION BAG THAT DISCHARGES TO A DITCH OR SWALE FOR SMALL VOLUMES OF LOCALIZED DEWATERING.

XI. ELEMENT 11 – MAINTAIN BMPS.

(A) ALL TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL BMPS SHALL BE MAINTAINED AND REPAIRED AS NEEDED TO ASSURE CONTINUED PERFORMANCE OF THEIR INTENDED FUNCTION. ALL MAINTENANCE AND REPAIR SHALL BE CONDUCTED IN ACCORDANCE WITH BMPS.

(B) SEDIMENT CONTROL BMPS SHALL BE INSPECTED WEEKLY OR AFTER A RUNOFF–PRODUCING STORM EVENT DURING THE DRY SEASON AND DAILY DURING THE WET SEASON. ALL PROJECTS THAT DISTURB AN AREA GREATER THAN ONE ACRE SHALL HAVE A CERTIFIED EROSION CONTROL LEAD AVAILABLE TO THE SITE. THIS EROSION CONTROL LEAD SHALL BE RESPONSIBLE TO PROVIDE OVERVIEW OF ONGOING DAY–TO–DAY EROSION CONTROL REQUIREMENTS. THE EROSION CONTROL LEAD SHALL (WITHIN 24 HOURS) REPORT TO THE CITY AND DEPARTMENT OF ECOLOGY ANY SITE DISCHARGES THAT EXCEED STATE WATER QUALITY STANDARDS THAT HAVE OR ARE LIKELY TO HAVE ENTERED WATERS OF THE STATE.

(C) ALL TEMPORARY EROSION AND SEDIMENT CONTROL BMPS SHALL BE REMOVED WITHIN 30 DAYS AFTER FINAL SITE STABILIZATION IS ACHIEVED OR AFTER THE TEMPORARY BMPS ARE NO LONGER NEEDED. TRAPPED SEDIMENT SHALL BE REMOVED OR STABILIZED ON SITE. DISTURBED SOIL AREAS RESULTING FROM REMOVAL OF BMPS OR VEGETATION SHALL BE PERMANENTLY STABILIZED.

XII. ELEMENT 12 – MANAGE THE PROJECT.

(A) PHASING OF CONSTRUCTION. DEVELOPMENT PROJECTS SHALL BE PHASED WHERE FEASIBLE IN ORDER TO PREVENT, TO THE MAXIMUM EXTENT PRACTICABLE, THE TRANSPORT OF SEDIMENT FROM THE DEVELOPMENT SITE DURING CONSTRUCTION. REVEGETATION OF EXPOSED AREAS AND MAINTENANCE OF THAT VEGETATION SHALL BE AN INTEGRAL PART OF THE CLEARING ACTIVITIES FOR ANY PHASE.

(B) WHEN ESTABLISHING THESE PERMITTED CLEARING AND GRADING AREAS, CONSIDERATION SHOULD BE GIVEN TO MINIMIZING REMOVAL OF EXISTING TREES AND MINIMIZING DISTURBANCE/COMPACTION OF NATIVE SOILS EXCEPT AS NEEDED FOR BUILDING PURPOSES. PERMITTED CLEARING AND GRADING AREAS AND ANY OTHER AREAS REQUIRED TO PRESERVE CRITICAL OR SENSITIVE AREAS, BUFFERS, NATIVE GROWTH PROTECTION EASEMENTS, OR TREE RETENTION AREAS, SHALL BE DELINEATED ON THE SITE PLANS AND THE DEVELOPMENT SITE.

(C) COORDINATION WITH UTILITIES AND OTHER CONTRACTORS. THE PRIMARY PROJECT PROPONENT SHALL EVALUATE, WITH INPUT FROM UTILITIES AND OTHER CONTRACTORS, THE STORMWATER MANAGEMENT REQUIREMENTS FOR THE ENTIRE PROJECT, INCLUDING THE UTILITIES, WHEN PREPARING THE CONSTRUCTION SWPPP.

(D) INSPECTION AND MONITORING. ALL BMPS SHALL BE INSPECTED, MAINTAINED, AND REPAIRED AS NEEDED TO ASSURE CONTINUED PERFORMANCE OF THEIR INTENDED FUNCTION.

(E) FOR ANY PROJECT DISTURBING MORE THAN ONE ACRE, A CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL SHALL BE IDENTIFIED IN THE CONSTRUCTION SWPPP AND SHALL BE ON SITE OR ON CALL AT ALL TIMES. CERTIFICATION MAY BE THROUGH THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION/ASSOCIATED GENERAL CONTRACTORS (WSDOT/AGC) CONSTRUCTION SITE EROSION AND SEDIMENT CONTROL CERTIFICATION PROGRAM OR ANY EQUIVALENT LOCAL OR NATIONAL CERTIFICATION AND/OR TRAINING PROGRAM, IN THE CITY'S DISCRETION.

(F) WHENEVER INSPECTION AND/OR MONITORING REVEALS THAT THE BMPS IDENTIFIED IN THE CONSTRUCTION SWPPP ARE INADEQUATE, DUE TO THE ACTUAL DISCHARGE OF OR POTENTIAL TO DISCHARGE A SIGNIFICANT AMOUNT OF ANY POLLUTANT, THE SWPPP SHALL BE MODIFIED, AS APPROPRIATE, IN A TIMELY MANNER.

(G) MAINTENANCE OF THE CONSTRUCTION SWPPP. THE CONSTRUCTION SWPPP SHALL BE RETAINED ON SITE. THE CONSTRUCTION SWPPP SHALL BE MODIFIED WHENEVER THERE IS A SIGNIFICANT CHANGE IN THE DESIGN, CONSTRUCTION, OPERATION, OR MAINTENANCE OF ANY BMP.

XIII. ELEMENT 13 – PROTECT LOW IMPACT DEVELOPMENT BMPS.
(A) PROTECT ALL BIORETENTION AND RAIN GARDEN BMPS FROM SEDIMENTATION THROUGH INSTALLATION AND MAINTENANCE OF EROSION AND SEDIMENT CONTROL BMPS ON PORTIONS OF THE SITE THAT DRAIN INTO THEM. RESTORE THE BMPS TO THEIR FULLY FUNCTIONING CONDITION IF THEY ACCUMULATE SEDIMENT DURING CONSTRUCTION. RESTORING THE BMP MUST INCLUDE REMOVAL OF SEDIMENT AND ANY SEDIMENT–LADEN BIORETENTION/RAIN GARDEN SOILS, AND REPLACING THE REMOVED SOILS WITH SOILS MEETING THE DESIGN SPECIFICATION.

(B) PREVENT COMPACTING BIORETENTION AND RAIN GARDEN BMPS BY EXCLUDING CONSTRUCTION EQUIPMENT AND FOOT TRAFFIC. PROTECT COMPLETED LAWN AND LANDSCAPED AREAS FROM COMPACTION BY CONSTRUCTION EQUIPMENT.

(C) CONTROL EROSION AND AVOID INTRODUCING SEDIMENT FROM SURROUNDING LAND USES ONTO PERMEABLE PAVEMENTS. DO NOT ALLOW MUDDY CONSTRUCTION EQUIPMENT ON THE BASE MATERIAL OR PAVEMENT. DO NOT ALLOW SEDIMENT–LADEN RUNOFF ONTO PERMEABLE PAVEMENTS OR BASE MATERIALS. PAVEMENTS FOULED WITH SEDIMENTS OR NO LONGER PASSING AN INITIAL INFILTRATION TEXT MUST BE CLEANED USING PROCEDURES FROM BOOK 4 OR THE MANUFACTURER'S PROCEDURES.

(D) KEEP ALL HEAVY EQUIPMENT OFF EXISTING SOILS UNDER LID FACILITIES THAT HAVE BEEN EXCAVATED TO FINAL GRADE TO RETAIN THE INFILTRATION RATE OF THE SOILS.

2. PROJECT DESCRIPTION

a. TOTAL PROJECT AREA. 0.28 ACRES

b. TOTAL PROPOSED IMPERVIOUS AREA. 0.17 ACRES

c. TOTAL PROPOSED AREA TO BE DISTURBED. 0.28 ACRES

3. EXISTING SITE CONDITIONS

a. DESCRIPTION OF EXISTING TOPOGRAPHY. EXISTING SLOPES THROUGHOUT THE PROJECT AREA ARE RELATIVE FLAT WITH SLOPES BETWEEN 1–3%.

b. DESCRIPTION OF EXISTING VEGETATION. THE MAJORITY OF THE SITE HAS BEEN DEVELOPED AND IS MADE UP OF IMPERVIOUS AREA. THERE ARE SOME EXISTING GRASSED AREAS THAT WILL BE RESTORED.

c. DESCRIPTION OF EXISTING DRAINAGE. THE PROJECT SITE IS LOCATED AT THE EXISTING POST POINT WASTEWATER TREATMENT PLANT. EXISTING STORMWATER ENTERS CATCH BASINS WHERE IT DISCHARGES ACCORDING TO ITS PERMIT

4. ADJACENT AREAS

a. DESCRIPTION OF ADJACENT AREAS WHICH MAY BE AFFECTED BY SITE DISTURBANCE:

i. STREAMS. THERE ARE NO STREAMS LOCATED NEARBY

ii. LAKES. THERE ARE NO LAKES LOCATED NEARBY.

iii. WETLANDS. THERE ARE NO WETLANDS WITHIN THE SITE.

iv. RESIDENTIAL AREAS. THERE ARE RESIDENTIAL AREAS LOCATED TO THE EAST OF THE SITE.

v. ROADS. THE PROJECT TAKES PLACE AT THE TREATMENT PLANT ADJACENT ROADS ARE MCKENZIE AVE AND 4TH ST.

DESCRIPTION OF THE DOWNSTREAM DRAINAGE PATH LEADING FROM THE SITE TO THE RECEIVING BODY OF WATER (MINIMUM DISTANCE OF 400 YARDS.) DRAINAGE PATTERNS ARE UNCHANGED FROM EXISTING CONDITIONS. THE CHANGES TO THE SITE WILL ALLOW FOR LESS PONDING.

5. CRITICAL AREAS

a. DESCRIPTION OF CRITICAL AREAS THAT ARE ON OR ADJACENT TO THE SITE. BELLINGHAM BAY IS LOCATED TO THE WEST OF THE SITE.

6. DESCRIPTION OF ONSITE SOILS SEE FINAL GEOTECH REPORT PREPARED BY GEONGINEERS, DATED ___________________.

7. EROSION PROBLEM AREAS. THERE ARE NO EROSION PROBLEM AREAS WITHIN THE PROJECT WORK AREA.

8. CONSTRUCTION PHASING.

CONSTRUCTION PHASING. TBD

STANDARD NOTES

1. APPROVAL OF THIS EROSION CONTROL (ESC) PLAN DOES NOT CONSTITUTE AN APPROVAL OF PERMANENT ROAD OR DRAINAGE DESIGN (E.G. SIZE AND LOCATION OF ROADS, PIPES, RESTRICTORS, CHANNELS, RETENTION FACILITIES, UTILITIES, ETC.).
2. THE IMPLEMENTATION OF THESE ESC PLANS AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF THESE ESC FACILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED AND APPROVED AND VEGETATION/LANDSCAPING IS ESTABLISHED.
3. THE BOUNDARIES OF THE CLEARING LIMITS SHOWN ON THIS PLAN SHALL BE CLEARLY FLAGGED IN THE FIELD PRIOR TO CONSTRUCTION. DURING THE CONSTRUCTION PERIOD, NO DISTURBANCE BEYOND THE FLAGGED CLEARING LIMITS SHALL BE PERMITTED. THE FLAGGING SHALL BE MAINTAINED BY THE CONTRACTOR FOR THE DURATION OF CONSTRUCTION.
4. THE ESC FACILITIES SHOWN ON THIS PLAN MUST BE CONSTRUCTED IN CONJUNCTION WITH ALL CLEARING AND GRADING ACTIVITIES, AND IN SUCH A MANNER AS TO ENSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DO NOT ENTER THE DRAINAGE SYSTEM, ROADWAYS, OR VIOLATE APPLICABLE WATER STANDARDS.
5. THE ESC FACILITIES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE ESC FACILITIES SHALL BE UPGRADED AS NEEDED FOR UNEXPECTED STORM EVENTS AND TO ENSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DO NOT LEAVE THE SITE.
6. THE ESC FACILITIES SHALL BE INSPECTED DAILY BY THE CONTRACTOR AND MAINTAINED AS NECESSARY TO ENSURE THEIR CONTINUED FUNCTIONING.
7. THE ESC FACILITIES ON INACTIVE SITES SHALL BE INSPECTED AND MAINTAINED A MINIMUM OF ONCE A MONTH OR WITHIN THE 48 HOURS FOLLOWING A MAJOR STORM EVENT.
8. AT NO TIME SHALL MORE THAN ONE FOOT OF TRAPPED SEDIMENT BE ALLOWED TO ACCUMULATE WITHIN A CATCH BASIN. ALL CATCH BASINS AND CONVEYANCE LINES SHALL BE CLEANED PRIOR TO PAVING. THE CLEANING OPERATION SHALL NOT FLUSH SEDIMENT LADEN WATER INTO THE DOWNSTREAM SYSTEM.
9. STABILIZED CONSTRUCTION ENTRANCES SHALL BE INSTALLED AT THE BEGINNING OF CONSTRUCTION AND MAINTAINED FOR THE DURATION OF THE PROJECT. ADDITIONAL MEASURES MAY BE REQUIRED TO ENSURE THAT ALL PAVED AREAS ARE KEPT CLEAN FOR THE DURATION OF THE PROJECT.
10. CONTRACTOR'S CESCL TO UPDATE TESC BMPS AS NEEDED AND AS DIRECTED BY THE CITY/ENGINEER. ANY CHANGES TO THE BMPS UTILIZED TO MANAGE CONSTRUCTION STORMWATER MUST BE APPROVED BY THE ENGINEER OR CITY INSPECTOR.

Call 811
two business days
before you dig

PAUL M. THO
017120
PRELIMINARY

WILSON
ENGINEERING

PLOT SETTINGS: WE AutoCAD PDF (High Quality Print).pc3, WE 22X34, Portrait, 1:1, WE APWA_SCREENED.ctb
W:\2023\2023–070 COB WWTP CAROLLO\DWG\V2023_2023–070 C2.1 TESC PLAN.DWG – 9/30/2024 4:31 PM – Paul Thomas

Date	No	Revision	By
	4	INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION	
	3		
	2		
	1		

PROJECT ENGINEER PMT
DESIGNED/DRAWN PMT
INSPECTOR MFM

DIRECTOR PUBLIC WORKS _______
CITY ENGINEER _______
ASSISTANT DIRECTOR _______

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. As Shown
Vert. As Shown

DATUM
H: NAD 83/98
V: NAVD 88

Job. No. 2023-070
Date 10/07/2024
Field Bk. _______

POST POINT RESOURCE RECOVERY PLANT
TEMPORARY EROSION AND SEDIMENT CONTROL NOTES

DRAWING NO.
020C105
SHEET NO.

CONTACT PERSON: STEPHEN DAY, P.E., S.E. , PROJECT ENGINEER AT (360) 778-7922

EROSION CONTROL GENERAL NOTES

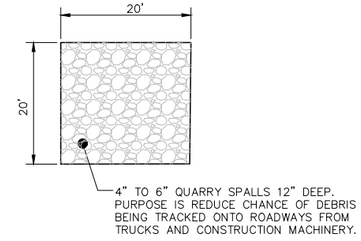
1. BMPS: BEST MANAGEMENT PRACTICES (BMPS) REFERRED TO ON THIS PLAN AND IN THESE NOTES SHALL BE CONSTRUCTED AND MAINTAINED AS DESCRIBED IN DEPARTMENT OF ECOLOGY'S STORMWATER MANAGEMENT MANUAL FOR WESTERN WASHINGTON, VOL II, CONSTRUCTION STORMWATER POLLUTION PREVENTION.
2. EXTENT: THE EXTENT OF EROSION AND SEDIMENTATION CONTROL MEASURES IS DEPENDENT ON WEATHER CONDITIONS, SITE SLOPES, LENGTH OF TIME GROUND IS LEFT EXPOSED, AND THE AREA OF EXPOSED GROUND. THE CONTRACTOR SHALL AT ALL TIMES MINIMIZE THE RISK OF SITE EROSION BY CAREFUL SCHEDULING AND BY IMPLEMENTING AND MAINTAINING BMPS UNTIL THE SITE IS PERMANENTLY STABILIZED.
3. VEGETATION: EXISTING VEGETATION SHALL BE PRESERVED WHERE ATTAINABLE.
4. ADJACENT PROPERTIES: PROPERTIES ADJACENT TO THE PROJECT SHALL BE PROTECTED FROM SEDIMENT DEPOSITION.
5. REMOVAL OF BMPS: ALL TEMPORARY EROSION AND SEDIMENT CONTROL BMPS SHALL BE REMOVED WITHIN 30 DAYS AFTER FINAL SITE STABILIZATION IS ACHIEVED OR AFTER THE TEMPORARY BMPS ARE NO LONGER NEEDED. TRAPPED SEDIMENT SHALL BE REMOVED OR STABILIZED ON-SITE. DISTURBED SOIL AREAS RESULTING FROM REMOVAL SHALL BE PERMANENTLY STABILIZED.
6. OTHER REQUIREMENTS: THE ENGINEER, OWNER, CITY OF BELLINGHAM, DEPARTMENT OF ECOLOGY, OR OTHER AGENCIES MAY REQUIRE BMPS IN ADDITION TO WHAT IS SHOWN ON THIS PLAN IF NECESSARY TO PREVENT VIOLATIONS OF SURFACE WATER QUALITY. THE CONTRACTOR SHALL IMPLEMENT THE BMPS AS REQUIRED.
7. THE IMPLEMENTATION OF THESE ESC PLANS AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF THESE ESC FACILITIES IS THE RESPONSIBILITY OF THE APPLICANT/CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED AND APPROVED AND VEGETATION/LANDSCAPING IS ESTABLISHED.
8. THE ESC FACILITIES SHOWN ON THIS PLAN MUST BE CONSTRUCTED IN CONJUNCTION WITH ALL CLEARING AND GRADING ACTIVITIES, AND IN SUCH A MANNER AS TO INSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DO NOT ENTER THE DRAINAGE SYSTEM, ROADWAYS, OR VIOLATE APPLICABLE WATER STANDARDS.
9. THE ESC FACILITIES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE ESC FACILITIES SHALL BE UPGRADED AS NEEDED FOR UNEXPECTED STORM EVENTS AND TO ENSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DO NOT LEAVE THE SITE.
10. OBTAIN PERMISSION AND/OR PERMIT APPROVAL AS REQUIRED FROM CITY OF BELLINGHAM PRIOR TO ANY DISCHARGES TO THE SANITARY SEWER SYSTEM.
11. WHERE CONFLICTING REQUIREMENTS WITHIN THE CONSTRUCTION ELEMENTS ARE PRESENT, THE MORE RESTRICTIVE REQUIREMENT SHALL HAVE PRECEDENCE.
12. CONVEYANCE BYPASS: IF REQUIRED, PROVISION FOR BYPASS OF STORMWATER CONVEYANCE SHALL BE PROVIDED. BYPASS SHALL BE INSTALLED FOR THE DURATION OF THE WORK. MATERIALS FOR BYPASS NEED NOT BE INSTALLED WHILE WORK IS IN PROGRESS AT A PARTICULAR LOCATION, BUT MATERIALS AND EQUIPMENT FOR IMMEDIATE INSTALLATION SHALL BE ON HAND. BYPASS SHALL BE IN PLACE WHILE SITE IS UNATTENDED FOR GREATER THAN 12 HOURS. A TRENCH MAY BE DUG FOR THE BYPASS PRIOR TO INSTALLATION OF BYPASS IF NECESSARY AND FEASIBLE. ANY PIPING USED FOR BYPASS SHALL BE OF A DIAMETER AT LEAST 2/3 OF THE EXISTING PIPE/CULVERT DIAMETER.
13. PUBLIC RIGHTS-OF WAY SHALL BE KEPT IN A CLEAN AND SERVICEABLE CONDITION AT ALL TIMES. IN THE EVENT MATERIALS ARE INADVERTENTLY DEPOSITED ON ROADWAYS, THE MATERIAL SHALL BE PROMPTLY REMOVED. MATERIALS ARE TO BE SWEPT AND REMOVED PRIOR TO ANY STREET FLUSHING. PUBLIC AND PRIVATE DRAINAGE WAYS SHALL BE PROTECTED FROM POLLUTION. NO MATERIAL IS TO BE DISCHARGED TO OR DEPOSITED IN STORMWATER SYSTEMS THAT MAY RESULT IN VIOLATION OF STATE OR FEDERAL WATER QUALITY STANDARDS.
14. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONSTRUCTING AND MAINTAINING EROSION CONTROL MEASURES (SILT FENCE, SILT PONDS, CATCH BASIN FILTERS, ETC.) THROUGHOUT THE DURATION OF THE PROJECT. ALL EROSION CONTROL WORK IS CONSIDERED INCIDENTAL TO THE ITEMS OF WORK IN THE CONTRACT FOR THIS PROJECT.
15. ALL CATCH BASINS WITHIN THE PROJECT LIMITS SHALL BE CLEANED OUT AT THE COMPLETION OF THE PROJECT AND ANY MATERIAL REMOVED SHALL BE PROPERLY DISPOSED OF. IN ADDITION, INLET PROTECTION MUST BE PROVIDED FOR ALL EXISTING CATCH BASINS DURING CONSTRUCTION.
16. DURING ANY DITCH, CREEK & DRAINAGE WORK WATER SHALL BE DIVERTED AROUND THE PROJECT WITH A PUMP OR OTHER ADEQUATE METHOD APPROVED BY THE ENGINEER.
17. CONCRETE PROCESS WATER AND SLURRY FROM PAVEMENT CUTTINGS SHALL NOT BE ALLOWED TO ENTER ANY DRAINAGE CONVEYANCE. SLURRY/CUTTINGS SHALL NOT REMAIN ON PAVEMENT OVERNIGHT. ALL SAWCUTTING AND SURFACING OPERATIONS SHALL USE BMP C152 FOR POLLUTION PREVENTION.
18. CAREFULLY PLACE PROPOSED BEST MANAGEMENT PRACTICES TO MAINTAIN UNRESTRICTED ACCESS TO RESIDENTIAL, PEDESTRIAN, AND BUSINESS USES IN THIS AREA THROUGHOUT CONSTRUCTION. CLOSURES TO BE COORDINATED THROUGH PROJECT ENGINEER

BMP C105 – STABILIZED CONSTRUCTION ENTRANCE:

PURPOSE: CONSTRUCTION ENTRANCES ARE STABILIZED TO REDUCE THE AMOUNT OF SEDIMENT TRANSPORTED ONTO PAVED ROADS BY VEHICLES OR EQUIPMENT BY CONSTRUCTING A STABILIZED PAD OF QUARRY SPALLS AT ENTRANCES TO THE CONSTRUCTION SITES.

INSTALLATION: A SEPARATIONS GEOTEXTILE SHALL BE PLACED UNDER THE SPALLS TO PREVENT FINE SEDIMENT FROM PUMPING UP INTO THE ROCK PAD. THE GEOTEXTILE SHALL MEET THE FOLLOWING STANDARDS: GRAB TENSILE STRENGTH (ASTM D4751) = 200 PSI MINIMUM, GRAB TENSILE ELONGATION (ASTM D4632) = 30% MAXIMUM, MULLEN BURST STRENGTH (ASTM D3786-80A) = 400 PSI MINIMUM, AOS (ASTM D4751) = 20-45 (U.S. STANDARD SIEVE SIZE).

MAINTENANCE: QUARRY SPALLS SHALL BE ADDED IF THE PAD IS NO LONGER IN ACCORDANCE WITH SPECIFICATIONS.



1 BMP C105 CONSTRUCTION ENTRANCE
NOT TO SCALE

BMP C123 – PLASTIC COVERING

PURPOSE: Plastic covering provides immediate, short-term erosion protection for emergency protection of slopes during heavy rains.

INSTALLATION: Place plastic up and down, not across slope with a minimum 8-inch overlap at seams. Place plastic end in a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath. Sandbags shall be placed ever 3 to 6 feet along seams and a wooden stake pounded in each to hold in place. If erosion of the toe is likely, a gravel berm riprap, or on the suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff. Plastic sheeting shall have a minimum thickness of 0.06 millimeters.

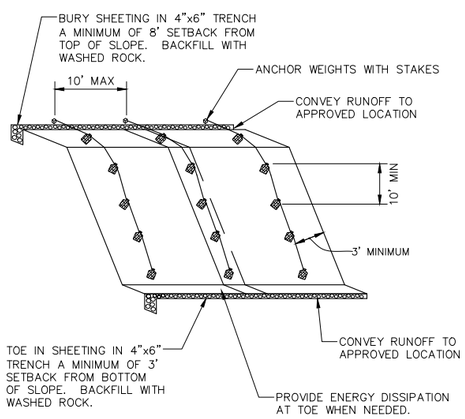
MAINTENANCE. Torn sheet must be replaced and open seams repaired. When plastic is no longer needed, it shall be completely removed.

BMP C152: SAWCUTTING AND SURFACING POLLUTION PREVENTION

Purpose: Sawcutting and surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. This BMP is intended to minimize and eliminate process water and slurry from entering waters of the State.
- Conditions of Use: Anytime sawcutting or surfacing operations take place, these management practices shall be utilized. Sawcutting and surfacing operations include, but are not limited to: sawing, coring, grinding, roughening, hydro-demolition, and bridge and road surfacing.

Design and Installation Specifications:
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance.
- Collected slurry and cuttings shall be disposed of in a manner that does not violate groundwater or surface water quality standards.
- Process water that is generated during hydro-demolition, surface roughening or similar operations shall not drain to any natural or constructed drainage conveyance and shall be disposed of in a manner that does not violate groundwater or surface water quality standards.
- Cleaning waste material and demolition debris shall be handled and disposed of in a manner that does not cause contamination of water. If the area is swept with a pick-up sweeper, the material must be hauled out of the area to an appropriate disposal site.

Maintenance Standards: Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the state. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and vacuum trucks.



NOTES:

1. TIRES, SANDBAGS, OR EQUIVALENT MAY BE USED TO WEIGH DOWN PLASTIC SHEETING.
2. SEAMS BETWEEN SHEETS MUST OVERLAP A MINIMUM OF 12" AND BE WEIGHTED OR TAPED.
3. PLASTIC SHEETING SHALL HAVE A MINIMUM THICKNESS OF 6 MIL.
4. DUE TO RAPID RUNOFF CAUSED BY PLASTIC SHEETING, THIS METHOD SHALL NOT BE USED UPSLOPE OF AREAS THAT MIGHT BE ADVERSELY IMPACTED BY CONCENTRATED RUNOFF.
5. CONSTRUCT BERM OR SWALE AT TOP OF SLOPE AS DIRECTED BY THE CLEARING AND GRADING INSPECTOR.
6. CONSTRUCT DITCH AT BASE OF SLOPE AS REQUIRED BY CITY, AND DISCHARGE TO APPROVED LOCATION.

2 BMP C123 – PLASTIC COVERING FOR SLOPES & STOCKPILES
NOT TO SCALE

BMP C151: CONCRETE HANDLING

Purpose: Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. This BMP is intended to minimize and eliminate concrete process water and slurry from entering waters of the state.
- Conditions of Use: Any time concrete is used, these management practices shall be utilized. Concrete construction projects include, but are not limited to: curbs, sidewalks, roads, bridges, foundations, floors, and runways.

Design and Installation Specifications:
- Concrete truck chutes, pumps, and internals shall be washed out only into formed areas awaiting installation of concrete or asphalt.
- Unused concrete remaining in the truck and pump shall be returned to the originating batch plant for recycling.
- Hand tools including, but not limited to, screeds, shovels, rakes, floats, and trowels shall be washed off only into formed areas awaiting installation of concrete or asphalt.
- Equipment that cannot be easily moved, such as concrete pavers, shall only be washed in areas that do not directly drain to natural or constructed stormwater conveyances.
- Washdown from areas such as concrete aggregate driveways shall not drain directly to natural or constructed stormwater conveyances.
- When no formed areas are available, washwater and leftover product shall be contained in a lined container. Contained concrete shall be disposed of in a manner that does not violate groundwater or surface water quality standards.

Maintenance Standards: Containers shall be checked for holes in the liner daily during concrete pours and repaired the same day.

BMP C220 – STORM DRAIN INLET PROTECTION

PURPOSE: To prevent coarse sediment from entering drainage system prior to permanent stabilization of the disturbed area.

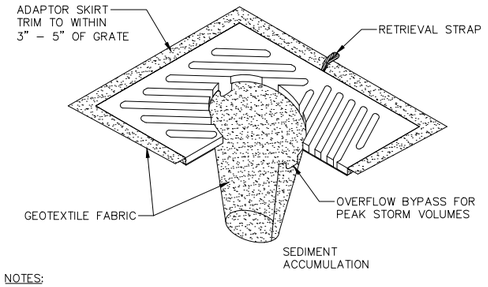
INSTALLATION: Block and Gravel Filters or Gravel and Wire Mesh Filters shall be installed on catch basins within the construction limits where erosion is a risk. Catch Basin Filters (inserts) shall be installed in existing catch basins outside of the project limits where sedimentation is a risk.

Block and Gravel Filters / Gravel and Wire Mesh Filters. Install to a height of 1 to 2 feet above the inlet. Recess the first row 2 inches into the ground for stability. Support subsequent courses by placing a 2x4 through the block opening. Do not use mortar. Lay some blocks in the bottom row on their side for dewatering the pool. Place hardware cloth or comparable wire mesh with 1/2-inch openings over all block openings.

Catch Basin Filters. Filters inserted in catch basins just below the grating shall be designed by the manufacturer for use at construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. Inserts shall have 5 cubic feet of sediment storage, dewatering provisions, and a high-flow bypass that will not clog under normal use at a construction site.

Through Curb Inlets. Install sand bags to prevent flow from entering curb-cut inlet in addition to installing catch basin insert.

MAINTENANCE: Catch basin filters shall be inspected frequently, especially after storm events. If it becomes clogged, it shall be cleaned or replaced. For gravel filters, when the stone becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Do not wash sediment into storm drains while cleaning.



NOTES:

1. INSERT SHALL BE INSTALLED PRIOR TO CLEARING AND GRADING ACTIVITY, OR UPON PLACEMENT OF A NEW CATCH BASIN.
2. SEDIMENT SHALL BE REMOVED FROM THE UNIT WHEN IT BECOMES HALF FULL .
3. SEDIMENT REMOVAL SHALL BE ACCOMPLISHED BY REMOVING THE INSERT, EMPTYING, AND RE-INSERTING IT INTO THE CATCH BASIN.

3 BMP C220 – CATCH BASIN INSERT
NOT TO SCALE

PAUL M. THOMAS — STATE OF WASHINGTON — 21720 — REGISTERED PROFESSIONAL ENGINEER — PRELIMINARY — NOT FOR CONSTRUCTION

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DESIGNED/DRAWN PMT
INSPECTOR MFM

DIRECTOR PUBLIC WORKS
CITY ENGINEER
ASSISTANT DIRECTOR

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. As Shown
Vert. As Shown

DATUM
H: NAD 83/98
V: NAVD 88

Job. No. 2023-070
Date 10/07/2024
Field Bk.

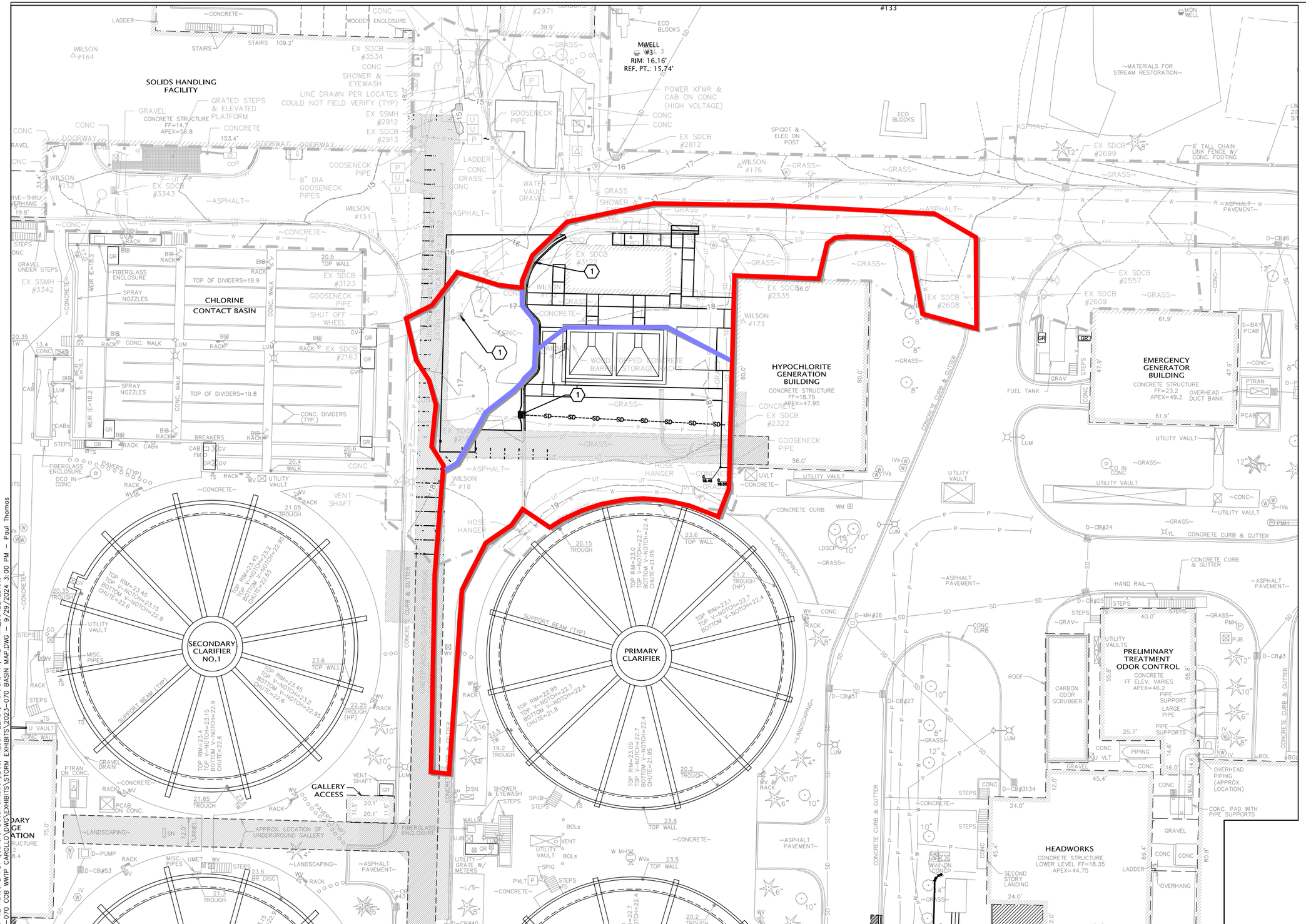
POST POINT RESOURCE RECOVERY PLANT
TEMPORARY EROSION AND SEDIMENT CONTROL DETAILS

DRAWING NO. 020C106
SHEET NO.

CONTACT PERSON: STEPHEN DAY, P.E., S.E. , PROJECT ENGINEER AT (360) 778-7922

PLOT SETTINGS: WE AutoCAD PDF (High Quality Print).pc3, WE 22X34, Portrait, 1:1, WE APWA_SCREENED.ctb
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APPENDIX D – Basin Map



LEGEND
= DRAINAGE BASIN
= BASIN SUB DELINEATION
= DRAINAGE ARROW

KEYED NOTES

(1) EXISTING INLET

20 0 20 40
SCALE HORIZONTAL SCALE FEET

WILSON ENGINEERING

PLOT SETTINGS: W:\2023\2023-070 COB WWTP CAROLLO\DWG\EXHIBITS\STORM EXHIBITS\2023-070 BASIN MAP.DWG - 9/29/2024 3:00 PM - Paul Thomas
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Date	No	Revision	By
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PROJECT ENGINEER	MHW
DESIGNED/DRAWN	MHW
INSPECTOR	XXX

DIRECTOR PUBLIC WORKS	ECJ
CITY ENGINEER	MLW
ASSISTANT DIRECTOR	MAO

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE	
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Vert.	As Shown

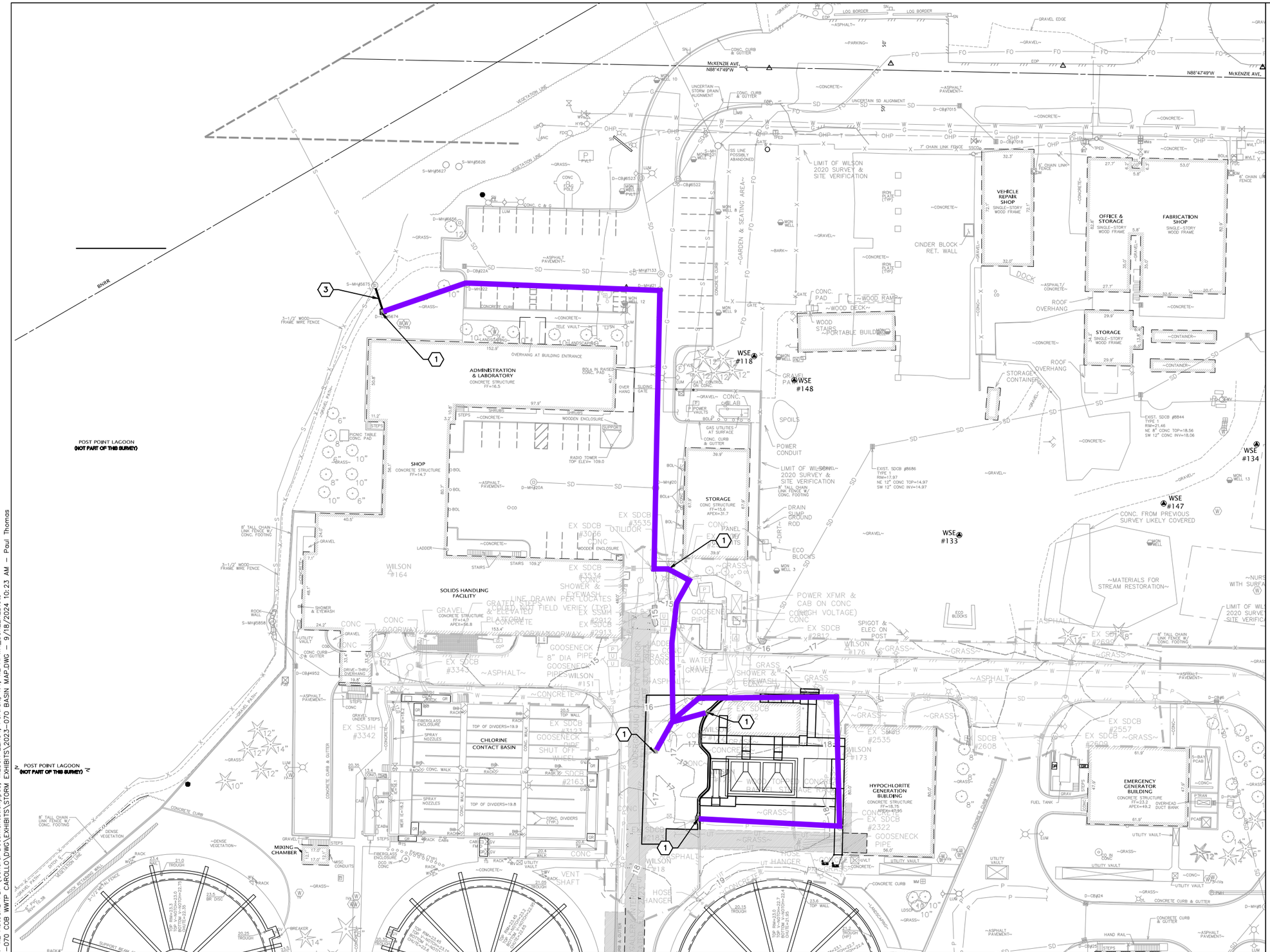
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V: NAVD 88	

Job. No.	2023-070
Date	8/23/2024
Field Bk.	

PRIMARY SLUDGE TANK REPLACEMENT PROJECT
APPENDIX D - BASIN MAP

DRAWING NO. XX
SHEET NO.

CONTACT PERSON: _____, PROJECT ENGINEER AT (360) 778-7922



PLOT SETTINGS: W:\2023\2023-070 COB WWTP CAROLLO\DWG\EXHIBITS\STORM EXHIBITS\2023-070 BASIN MAP.DWG — 9/18/2024 10:23 AM — Paul Thomas

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Date	No	Revision	By
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PROJECT ENGINEER	MHW
DESIGNED/DRAWN	MHW
INSPECTOR	XXX

DIRECTOR PUBLIC WORKS	ECJ
CITY ENGINEER	MLW
ASSISTANT DIRECTOR	MAO

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. As Shown
Vert. As Shown

DATUM
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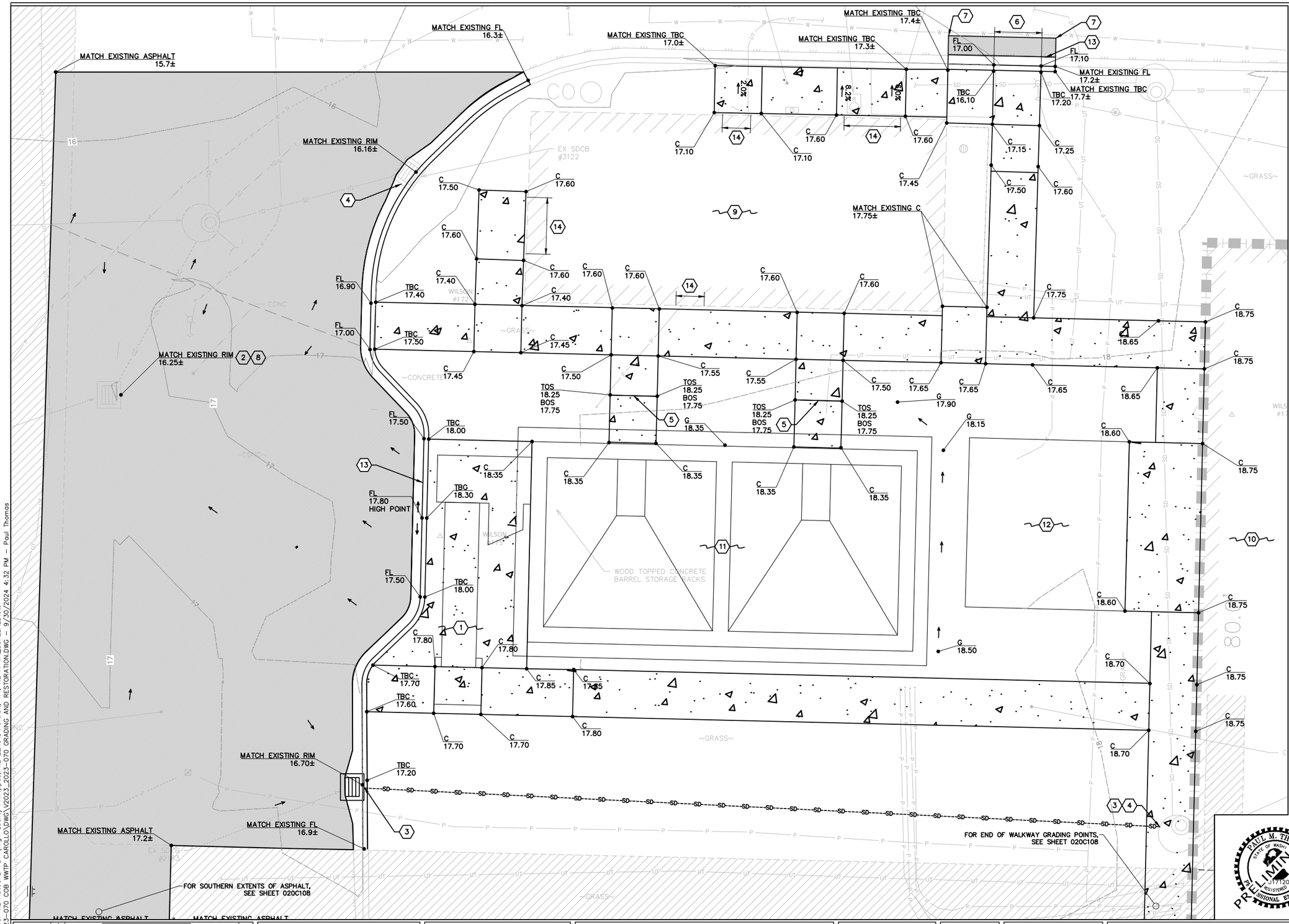
Job. No. 2023-070
Date 8/23/2024
Field Bk.

PRIMARY SLUDGE TANK REPLACEMENT PROJECT
APPENDIX D - OVERALL STORMWATER CONVEYANCE

DRAWING NO. XX
SHEET NO.

CONTACT PERSON: _____, PROJECT ENGINEER AT (360) 778-7922

APPENDIX E – Stormwater Plans



LEGEND

TBC = TOP BACK OF CURB
FL = GUTTER FLOW LINE
C = CONCRETE
FG = FINISHED GRADE
BOS = BOTTOM OF STAIR
TOS = TOP OF STAIR
G = LANDSCAPING
→ = DRAINAGE DIRECTION

KEYED NOTES

1. STAIR ACCESS SEE SHEET 440S101 FOR DETAILS
2. REPLACE EXISTING FRAME AND GRATE (2 / 020C110)
3. RESTORE INLET AND PIPE TO PRE-CONSTRUCTION ELEVATIONS (1 / 020C110)
4. PROTECT EXISTING STORM STRUCTURE DURING CONSTRUCTION. USE GRADE RINGS TO MATCH PROPOSED GRADE AS NECESSARY.
5. STEP – 6" RISE
6. CURB CUT
7. MATCH EXISTING ASPHALT ELEVATION
8. CONTRACTOR TO ENSURE NEW ASPHALT EXTENTS DRAIN TO INLET
9. EXISTING SLUDGE STORAGE BUILDING FF = 17.60
10. EXISTING HYPOCHLORITE GENERATION BUILDING FF = 18.76
11. PROPOSED SLUDGE STORAGE TANKS SHEET 440S101 AND SHEET 440S102 FOR DETAILS
12. PROPOSED ODOR CONTROL SEE SHEET 440S101 FOR PAD GRADING
13. CURB AND GUTTER PER (2 / 020C109)
14. DOOR THRESHOLD. SEE SHEET 420S102 (CR314 / 800TC101)

SCALE HORIZONTAL SCALE 5 0 5 10 FEET

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PRELIMINARY PAUL M. THOMAS STATE OF WASHINGTON 17120 REGISTERED PROFESSIONAL ENGINEER

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CITY ENGINEER
ASSISTANT DIRECTOR

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

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Horiz. As Shown
Vert. As Shown

DATUM
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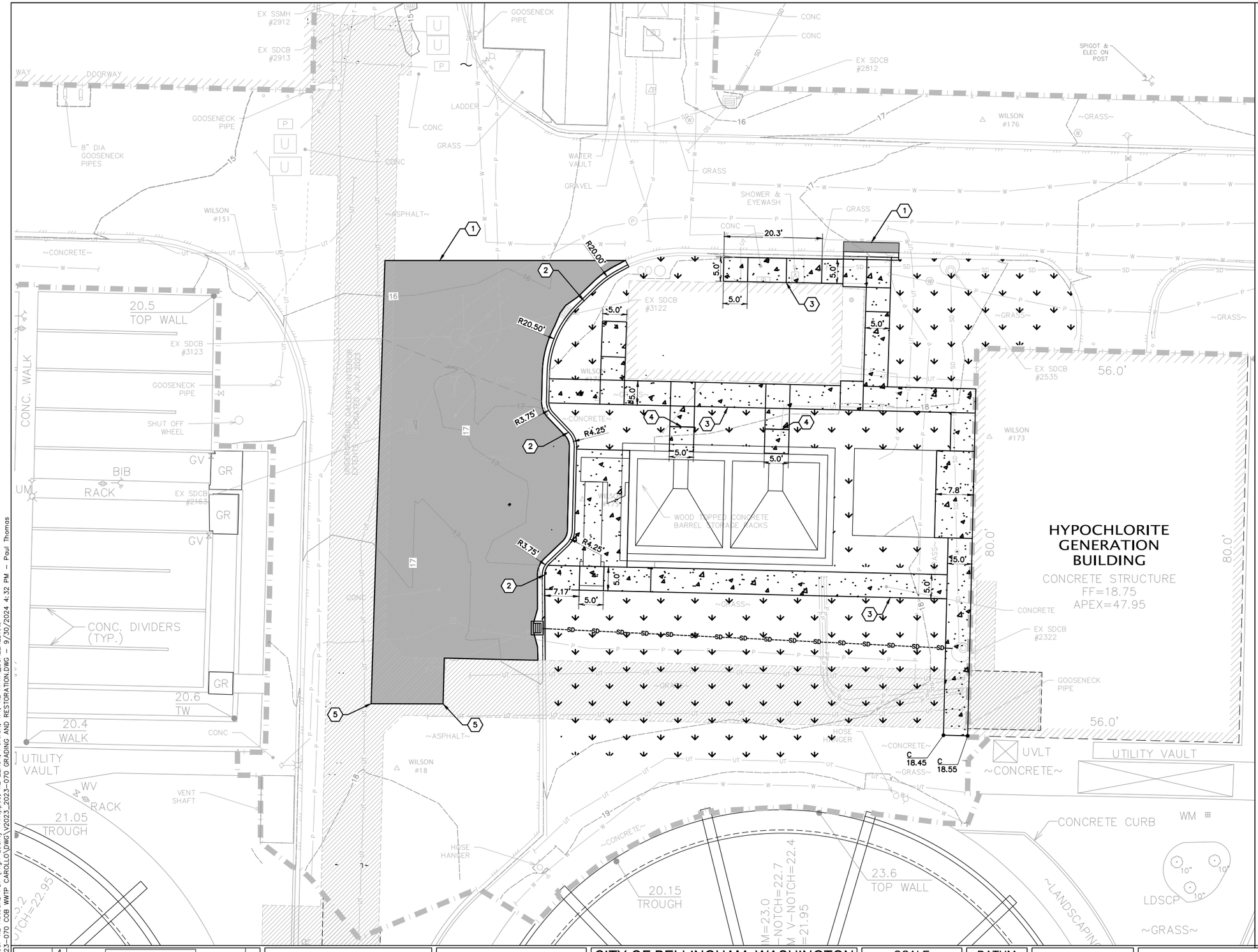
Job. No. 2023-070
Date 10/07/2024
Field Bk.

POST POINT RESOURCE RECOVERY PLANT
GRADING AND DRAINAGE PLAN

DRAWING NO. 020C107
SHEET NO.

CONTACT PERSON: STEPHEN DAY, P.E., S.E. , PROJECT ENGINEER AT (360) 778-7922

PLOT SETTINGS: W\2023\2023-070 COB WWTP CAROLLO\DWG\V2023_2023-070 GRADING AND RESTORATION.DWG – 9/30/2024 4:32 PM – Paul Thomas
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TESC LEGEND

= HOT MIX ASPHALT PER 3 / 020C110

= PERMANENT SEEDING, FERTILIZING, AND MULCHING FOR ALL DISTURBED AREAS NOT COVERED WITH HARD SURFACING PER SPECIFICATIONS

= CONCRETE SIDEWALK COB RCA CONCRETE MIX GSP 8-04

KEYED NOTES

1. REPLACED ASPHALT EXTENTS — 3 / 020C110
2. CURB AND GUTTER PER DETAIL — 2 / 020C109
3. SIDEWALK PER — 3 / 020C110
4. STAIR – 6" RISE
5. MATCH ELEVATION OF EXISTING ASPHALT

SCALE HORIZONTAL SCALE: 10 0 10 20 FEET

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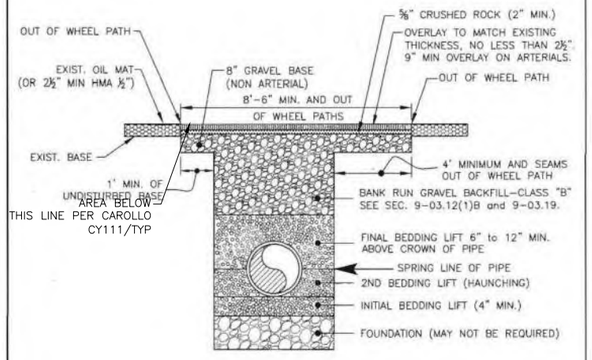
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DATUM: H: NAD 83/98; V: NAVD 88
Job. No. 2023-070
Date 10/07/2024
Field Bk.

POST POINT RESOURCE RECOVERY PLANT
SURFACE RESTORATION AND DIMENSION PLAN

DRAWING NO. 020C108
SHEET NO.

CONTACT PERSON: STEPHEN DAY, P.E., S.E. , PROJECT ENGINEER AT (360) 778-7922

PLOT SETTINGS: WE AutoCAD PDF (High Quality Print).pc3, WE 22X34, Portrait, 1:1, WE APWA_SCREENED.ctb
W:\2023\2023-070 COB WWTP CAROLLO\DWG\2023_2023-070 GRADING AND RESTORATION.DWG - 9/30/2024 4:32 PM - Paul Thomas



NOTES:

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF BELLINGHAM'S "STANDARD SPECIFICATIONS FOR UTILITY CUTS IN STREET AREA".

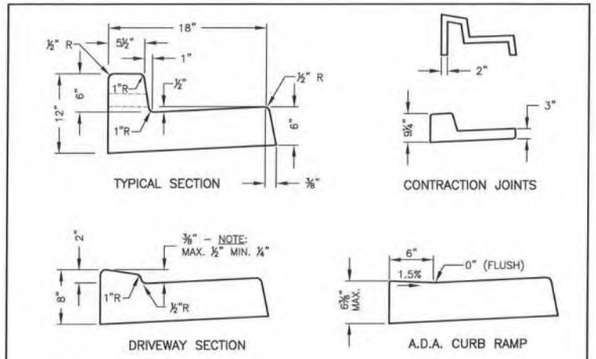
PAVEMENT OVERLAYS No.2, AND 3, TACK ALL EDGES AND HMA BASE SURFACE BEFORE PLACING HMA PAVEMENT. SEAL ALL JOINTS WITH HOT ASPHALT (AR-4000W) BETWEEN EXISTING AND NEW HMA PAVEMENT IMMEDIATELY AFTER FINISH ROLLING.

CONTRACTOR SHALL MATCH EXISTING SURFACES THAT ARE COLORED, TEXTURED, STAMPED OR INLAID WITH BRICK.

GRINDING FOR HMA BUTT JOINTS MAY START 4' MINIMUM FROM FACE OF GUTTER.

APPROVED		CITY OF BELLINGHAM	DRAWING
City Engineer	12/10/09 Date	LONGITUDINAL PAVEMENT REPAIR	ST-182

1 PAVEMENT REPAIR
NOT TO SCALE



GENERAL NOTES:

1. CONTRACTION JOINTS OF ONE OF THE TYPES SHOWN ABOVE TO BE PLACED 10' C/C. JOINTS MUST COMPLETELY SEVER THE STRUCTURE TO THE POINTS SHOWN. JOINTS MAY BE MADE BY INSERTING MIN. 3/16" BITUMINOUS FILLER DUMMY JOINTS. JOINTS SHALL BE CLEANED AND EDGED.
2. ALL RADII LESS THAN 100' SHALL USE FLEXIBLE WOOD OR METAL FORMS TO ELIMINATE ANGULAR POINTS AT 10' SECTION POINTS.
3. 2"ø PVC SCHD 40 WEEP HOLES TO BE PLACED ON EACH SIDE OF DRIVEWAY SECTION AND AT MAX. OF 60' C/C IN CUT SECTIONS WHERE SIDEWALK DRAIN NOT REQUIRED BY CITY ENGINEER.
4. ¾" EXPANSION JOINTS TO BE PLACED AT DRIVEWAY SECTIONS, CURB RETURNS, CURB RAMPS, & COLD JOINTS OR A MAX. OF 80' C/C. EXPANSION JOINTS SHALL PROTRUDE 1" BELOW THE BOTTOM OF GUTTER.
5. CONCRETE SHALL BE COMMERCIAL CONCRETE CLASS 3000 PER WSDOT SPEC. 6-02.3(2)B.
6. FINISHED WORK SHALL NOT VARY MORE THAN 1/16-INCH IN GRADE AND ¼-INCH IN ALIGNMENT WHEN CHECKED WITH A 10-FOOT STRAIGHT EDGE.
7. EXPOSED SURFACES SHALL BE BRUSHED WITH A FIBER HAIR BRUSH.
8. WHITE PIGMENTED OR TRANSPARENT CURING COMPOUND SHALL BE APPLIED AS OUTLINED IN THE STANDARD SPECIFICATIONS.
9. FURTHER REQUIREMENTS SHALL BE AS SPECIFIED IN THE STANDARD SPECIFICATIONS.

APPROVED		CITY OF BELLINGHAM	DRAWING
City Engineer	24 MAY 2018 Date	TYPE 'A' MODIFIED CURB AND GUTTER	CG-200

2 COB CURB AND GUTTER
NOT TO SCALE

PRELIMINARY
PAUL M. THOMAS — STATE OF WASHINGTON — 17120 — REGISTERED PROFESSIONAL ENGINEER

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PROJECT ENGINEER PMT
DESIGNED/DRAWN PMT
INSPECTOR MFM

DIRECTOR PUBLIC WORKS
CITY ENGINEER
ASSISTANT DIRECTOR

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. As Shown
Vert. As Shown

DATUM
H: NAD 83/98
V: NAVD 88

Job. No. 2023-070
Date 10/07/2024
Field Bk.

POST POINT RESOURCE RECOVERY PLANT
SITE RESTORATION DETAILS (1)

DRAWING NO. 020C109
SHEET NO.

CONTACT PERSON: STEPHEN DAY, P.E., S.E. , PROJECT ENGINEER AT (360) 778-7922

PLOT SETTINGS: WE AutoCAD PDF (High Quality Print).pc3, WE 22X34, Portrait, 1:1, WE APWA_SCREENED.ctb
W:\2023\2023-070 COB WWTP CAROLLO\DWG\V2023_2023-070 C4.X DETAILS.DWG - 9/30/2024 4:32 PM - Paul Thomas

BEDDING SPECIFICATIONS FOR PVC PIPE

THE FOLLOWING SUPPLEMENTAL SPECIFICATIONS ARE TO BE USED IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION, CURRENT EDITION:

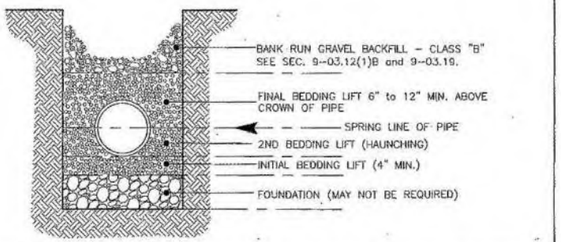
BEDDING FOR SEWERS, DRAINS AND CULVERTS FOR PVC PIPE–

BEDDING MATERIAL FOR PVC PIPE SHALL BE PEA GRAVEL CONFORMING TO THE FOLLOWING SPECIFICATIONS.

PEA GRAVEL -- PEA GRAVEL BEDDING SHALL BE A CLEAN MIXTURE FREE FROM ORGANIC MATTER AND CONFORMING TO THE FOLLOWING GRADATION WHEN TESTED IN ACCORDANCE WITH ASTM D422:

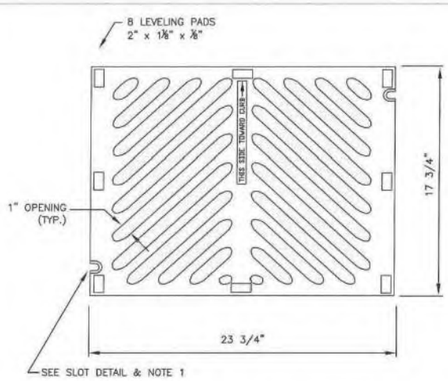
U.S. STANDARD SIEVE SIZE	PERCENT PASSING, BY WT.
½"	100
⅜"	95–100
#8	0–10
#200	0–3

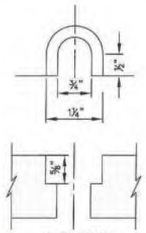
BACKFILL – WHEREVER A TRENCH IS EXCAVATED IN THE EXISTING OR PROPOSED ROADWAY, SIDEWALK OR OTHER AREAS WHERE SETTLEMENT WOULD BE DETRIMENTAL, THE ENTIRE TRENCH SHALL BE BACKFILLED WITH IMPORTED GRAVEL AND COMPACTED TO 95% OF MAXIMUM DENSITY.



APPROVED		CITY OF BELLINGHAM	DRAWING
City Engineer	11/8/07 Date	PVC PIPE BEDDING DETAILS	DR-538

1 PVC PIPE BEDDING
NOT TO SCALE





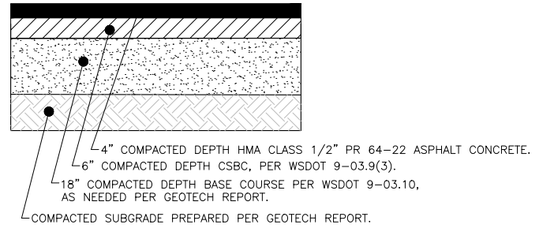
SLOT DETAIL

NOTES:

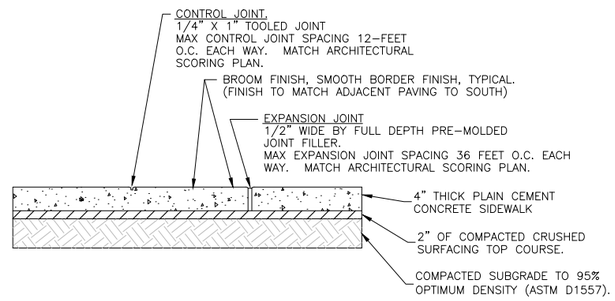
1. WHEN BOLT DOWN GRATES ARE SPECIFIED IN THE CONTRACT, PROVIDE TWO SLOTS IN THE GRATE THAT ARE VERTICALLY ALIGNED WITH THE HOLES IN THE FRAME. LOCATION OF BOLT DOWN SLOTS VARIES AMONG DIFFERENT MANUFACTURERS.
2. REFER TO STANDARD SPECIFICATION 9-05.15(2) FOR ADDITIONAL REQUIREMENTS.
3. FOR FRAME DETAILS, SEE STANDARD PLAN B-2A.
4. THE THICKNESS OF THE GRATE SHALL NOT EXCEED 1⅜"

APPROVED		CITY OF BELLINGHAM	DRAWING
City Engineer	5/29/14 Date	HERRINGBONE GRATE FOR CATCH BASINS AND INLETS	DR-502

2 CATCH BASIN GRATE
NOT TO SCALE



3 ASPHALT CONCRETE PAVEMENT SECTION
NOT TO SCALE



4 PEDESTRIAN PLAIN CEMENT CONCRETE PAVEMENT
NOT TO SCALE

811 Call 811 two business days before you dig

PAUL M. THOMAS STATE OF WASHINGTON 17120 REGISTERED PROFESSIONAL ENGINEER PRELIMINARY NOT FOR CONSTRUCTION

WILSON ENGINEERING

Date	No	Revision	By
	4		
	3	INTERMEDIATE DESIGN SUBMITTAL NOT FOR CONSTRUCTION	
	2		
	1		

PROJECT ENGINEER PMT
DESIGNED/DRAWN PMT
INSPECTOR MFM

DIRECTOR PUBLIC WORKS
CITY ENGINEER
ASSISTANT DIRECTOR

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. As Shown
Vert. As Shown

DATUM
H: NAD 83/98
V: NAVD 88

Job. No. 2023-070
Date 10/07/2024
Field Bk.

POST POINT RESOURCE RECOVERY PLANT SITE RESTORATION DETAILS (2)

DRAWING NO. 020C110
SHEET NO.

CONTACT PERSON: STEPHEN DAY, P.E., S.E. , PROJECT ENGINEER AT (360) 778-7922

PLOT SETTINGS: W:\2023\2023-070 COB WWTP CAROLLO\DWG\V2023_2023-070 C4.X DETAILS.DWG – 9/30/2024 4:32 PM – Paul Thomas
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APPENDIX F – Hydraulic Calculations

City of Bellingham Post Point Primary Sludge Tank Replacement
Existing and Proposed Land Cover Calculations
9/26/2024
Wilson Job No.: 2023-070

	Area (sqft)
Limits of disturbance	12310

OVERALL

Surface		Existing (SF)	Proposed[1] (SF)	Difference (SF)	
Building		2246	2112	134	removed
Vehicular Asphalt and Concrete (PGIS)		3161	3196	35	added
Non-Vehicular Concrete & Flatwork		1805	2298	493	added
Landscape		5098	4704	394	removed
	TOTAL AREA	12310	12310		

SUMMARY - IMPERVIOUS AND PERVIOUS

Surface		Existing (SF)	Proposed (SF)	Difference (SF)	
Impervious		7212	7606	394	added
Pervious		5098	4704	394	removed
	TOTAL AREA	12310	12310		

City of Bellingham Post Point Primary Sludge Tank Replacement
Conyeyance Calcs
9/26/2024
Wilson Job No.: 2023-070

AssetID	Pipe No (WE assigned)	Material	Upstream Invert (ft)	Downstream Invert (ft)	Diameter (in)	Length_Ft	Notes	Slope	Notes
0300475	1	PVC	9.04	6.82	15	10	Outfall	22.20%	
0279359	2	CPP	--	--	12	55	Trunkline	1.18%	
0279403	3	CPP	--	--	12	119	Trunkline	1.18%	
0279379	4	CPP	--	--	12	122	Trunkline	1.18%	
0279376	5	CPP	--	--	12	50	Trunkline	1.18%	
0279375	6	CPP	11.4	11.0	12	9	Trunkline	4.44%	
0279374	7	CPP	11.7	11.4	12	15	Trunkline	2.00%	
608412	8	CPP	12.6	11.7	12	87	Trunkline	1.03%	Flattest pipe, conveys all increased flows
0279369	9a	CPP	14.4	12.6	12	103	Lateral	1.75%	Recieves minimal amount of increased flow
0279371	9b	CPP	14.6	14.4	12	75	Lateral	0.27%	Recieves minimal amount of increased flow
0279370	9c	CPP	14.8	14.7	12	87	Lateral	0.11%	Recieves minimal amount of increased flow
0279373	10	CPP	13.4	12.6	12	22	Lateral	3.64%	
0279372	11	CPP	13.6	12.6	12	21	Lateral	4.76%	

Legend
From survey
From City IQ
Assumptions
worst case

Approximating pipe slopes	
Total length (ft)	346
Upstream Invert (ft)	11.0
Downstream Invert (ft)	6.82
Average drop across structures (ft)	0.02
No. of Structures	5
Average slope	0.012

Manning's Formula

$Q = A * 1.486/n * R^{2/3} * S^{1/2}$

- Q = Discharge (cu. ft./sec.)
- A = Cross-sectional Area of Flow (sq. ft.)
- n = Coefficient of Roughness
- R = Hydraulic Radius (ft.)
- S = Slope of Pipe (ft./ft.)

Hydraulic Radius

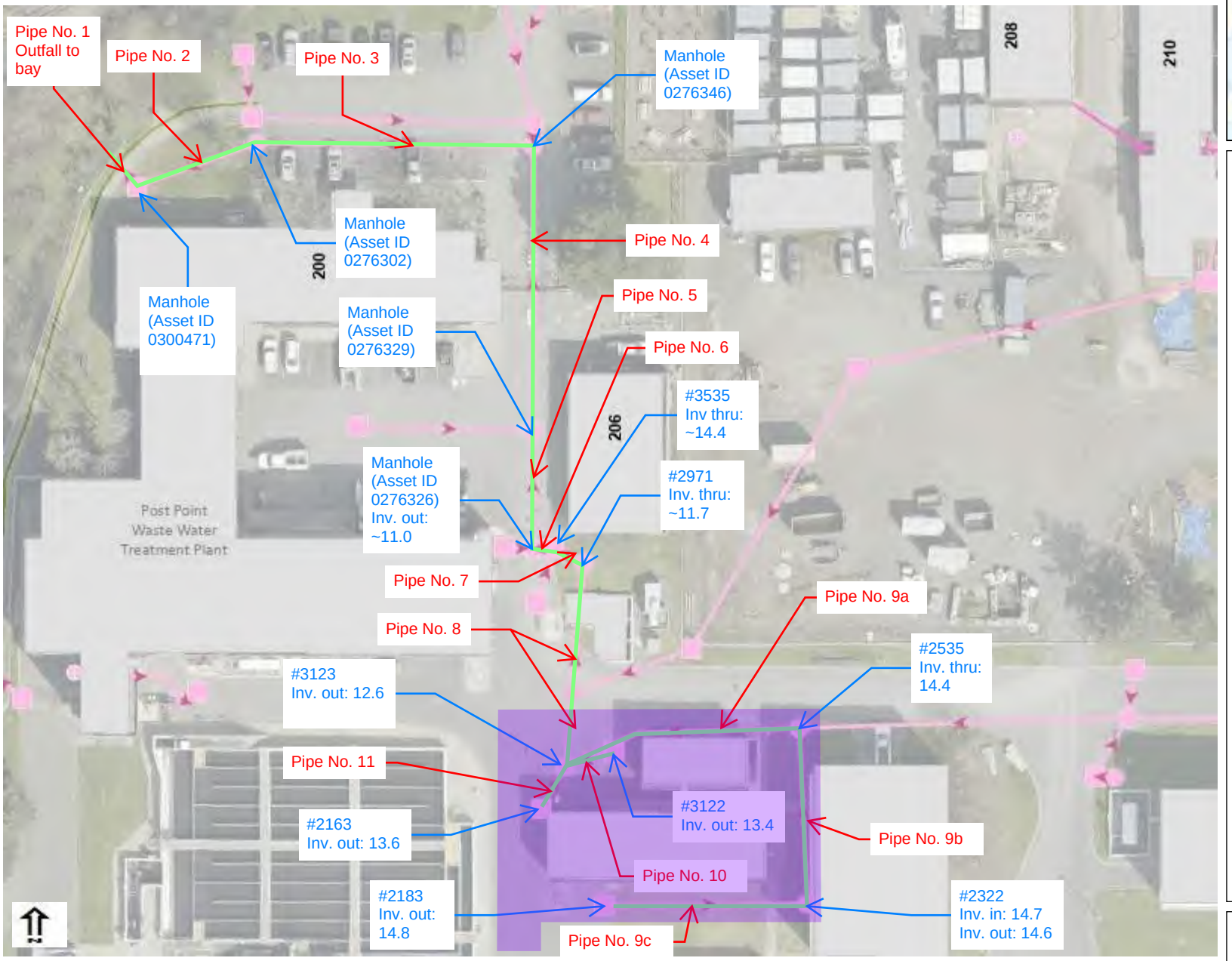
$R = A / P$

- R = Hydraulic Radius (ft.)
- A = Cross-sectional Area of Flow (sq. ft.)
- P = Wetted perimeter (ft.)

Manning's Formula Flow of pipe flowing mostly full		
n for CCP =	0.015	
A =	0.785398163	
P =	3.141592654	
R =	0.25	
S =	1.03%	
Q =	3.14	cfs (flowing full)
Q (rounded down)	3.00	cfs (flowing mostly full)
Q10 =	0.02	cfs
Q25 =	0.03	cfs
Increase for 10 year event	0.73%	
Increase for 25 year event	0.87%	

City of Bellingham WASHINGTON

CityIQ Map





Legend

- Buildings
- Docks
- Catch Basins
- Manhole
- Clean Out
- Pipe End
- Fitting
- Lateral Lines
  - Collector
  - Domestic
  - Drain
- Culvert
- Storm Main
  - City Mains, Active
  - City Mains, Under Construction
  - Private Mains, Active
  - Private Mains, Under Construction
- Ditch
- Open Channel Streams
- Tax Parcels
  - Care Facility
  - Hospital
  - Schools
  - <all other values>
- Schools
  - Colleges/Universities
  - Elementary, Middle, High Schools
  - Private School or Preschool
- Fire Stations
- City Boundary
- Urban Growth Area
- Trails
- Railroads
- Ferries
  - Residential
  - Street
  - Interstate

Notes

Printed: 9/26/2024 12:35:53 PM

= Project site

124 0 62 124 Feet

THIS MAP IS NOT TO BE USED FOR NAVIGATION

The City of Bellingham has compiled this information for its own use and is not responsible for any use of this information by others. The information found herein is provided simply as a courtesy to the public and is not intended for any third party use in any official, professional or other authoritative capacity. Persons using this information do so at their own risk and by such use agree to defend, indemnify and hold harmless the City of Bellingham as to any claims, damages, liability, losses or suits arising out of such use. Contact the Whatcom County Assessors office (360-778-5050) for the most up to date parcel information.

City of Bellingham Post Point Primary Sludge Tank Replacement
Rational Method Calcs
9/26/2024
Wilson Job No.: 2023-070

Rational Method
Q=CiA
Where:
Q = Peak discharge (cfs)
C = Runoff coefficient (dimensionless)
i = Rainfall intensity (inches per hour)
A = Drainage area (acres)

C (Runoff coefficient)

0.9 Pavement and roofs

I (Rainfal Intensity) - Bellingham https://wsdot.wa.gov/publications/manuals/fulltext/M23-03/M23-03.04Complete.pdf

$I = m/(T_c)^n$

T_c = 5 minutes

	m	n	I
10-year MRI	6.59	0.559	2.680163
25-year MRI	7.9	0.562	3.197466

New impervious area draining to storm system

394 sqft

0.009 acres

Q10 =	0.022	cfs	increase
Q25 =	0.026	cfs	increase

APPENDIX G – FEMA Flood Map



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTP://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
OTHER AREAS	NO SCREEN Areas Determined to be Outside the 0.2% Annual Chance Floodplain *Zone X*
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Accredited or Provisionally Accredited Levee, Dike, or Floodwall
	Non-accredited Levee, Dike, or Floodwall
	E 18.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	8 Coastal Transect
	Coastal Transect Baseline
OTHER FEATURES	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in the community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by the United States Geological Survey (USGS). This information was derived from digital orthophotography at a 2-foot resolution from photography dated 2009.

SCALE

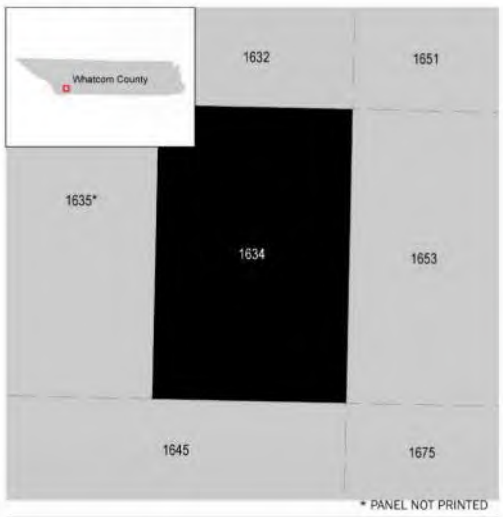
Map Projection:
NAD 1983 StatePlane Washington North FIPS 4601 Feet:
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 500 1,000 2,000 Feet

0 125 250 500 Meters

PANEL LOCATOR



* PANEL NOT PRINTED

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

WHATCOM COUNTY, WASHINGTON
and Incorporated Areas

PANEL 1634 OF 2025

FEMA

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
BELLINGHAM, CITY OF	530199	1634	E
WHATCOM COUNTY	530198	1634	E

VERSION NUMBER
2.3.2.1

MAP NUMBER
53073C1634E

MAP REVISED
JANUARY 18, 2019

APPENDIX B.6 EXHIBIT E:
POST POINT HERON COLONY MANAGEMENT RECOMMENDATIONS UPDATE 2019
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

The Post Point Resource Recovery Plant operates adjacent to an established Great Blue Heron Colony. Various protections for this colony exist in Federal, State and Local Regulations.

Noise emissions resulting from this project shall not exceed the recommendations as outlined in this Management Plan. Specifically, construction and operation activities shall not generate noise levels above 92db at the colony nesting sites. Additional noise and lighting constraints are outlined in Special Provision Specification Section 01_14_00. The Contractor's submittals for equipment and work processes shall provide acoustical information to demonstrate compliance with applicable requirements.

Post Point Heron Colony Management Recommendations Update 2019



prepared for:
The City of Bellingham Department of Public Works
Bellingham, WA

prepared by:
Ann Eissinger
Nahkeeta Northwest Wildlife Services
Corvallis, OR

Post Point Heron Colony
Management Recommendations Update 2019

prepared for:

The City of Bellingham Department of Public Works
2221 Pacific Street
Bellingham, WA 98229

prepared by:

Ann Eissinger
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Corvallis Or 97339
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Cover photograph by Alan Fritzberg

Post Point Heron Colony
Management Recommendations Update 2019

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Post Point Heron Colony
Management Recommendations Update 2019

1. INTRODUCTION

The focus of this document is to address the need for updated management guidelines and recommendations to protect and sustain the Post Point Heron Colony, the only colony of Great Blue Heron *(Ardea herodias)* nesting in the City of Bellingham. The colony is located near the marine shoreline in south Bellingham, on city owned property adjacent to Bellingham's Post Point Resource Recovery Plant (PPRRP), formerly known as the Post Point Wastewater Treatment Plant.

The Post Point Heron Colony established in its current location in 2000. Due to the need for more information about the herons, the City's Public Works Department, who manages the colony site, requested a biological evaluation of the colony in 2002 and later a management plan in 2003. When the 2003 Post Point Heron Colony Management Plan was prepared, the colony was 4 years old, and supported 10 active nests. Over time, the 2003 Management Plan has provided guidance in supporting and protecting the colony. Recommendations in the plan resulted in the 2005 baseline report for the colony followed by annual monitoring of the colony to track the colony and provide ongoing stewardship. Annual monitoring over the past 15 years has provided a wealth of information and a greater understanding of the herons, nesting behavior, colony dynamics and habitat use.

Over 20 years the colony has persisted in the same location and has supported up to 42 nesting pairs seasonally and fledged an estimated 1,000 young herons. Not only is this colony a valued ecosystem component and an important Critical Area supporting a state Priority species, but it is also a vital contributor to the resident Great Blue Heron population of the region.

In 2019 the City of Bellingham, Public Works Department requested a management plan update. This management update has been prepared with the same goal as the original 2003, which is: to define the conservation needs and management requirements necessary to sustain and perpetuate the Great Blue Heron's successful reproduction and use of the Post Point Heron Colony and associated habitat. In addition to updated management recommendations, this document will also provide a species summary, site and colony descriptions, and a synopsis of data observations over the past 20 years.

2. PURPOSE

The purpose of the Post Point Heron Colony Management Recommendations 2019 update is to provide current information about the heron colony and site conditions, and update the 2003 management recommendations. The revisions herein are based on newer Washington State Department of Fish and Wildlife guidelines for Great Blue Heron colony management, recent literature, and an informed understanding of the heron colony as a result of monitoring over 15 years. The 2003 management plan forms the foundation for this document and many of the heron related references and information are still valid.

This document is made up of 4 primary sections.

1) Background Information: species summary, regulatory review, site and habitat description.
2) Site History
3) Colony History and Chronology
4) Management and Recommendations: Heron Management Area description, habitat protective guidelines, buffers, reserve area and management recommendations.

The management and conservation of any wildlife area is founded on three key sources of information: regulatory guidelines, scientific literature and site specific information (empirical data). Management recommendations for Great Blue Heron colonies typically start with the delineation of the colony area and associated habitats, obtaining a baseline of the colony including its level of sensitivity, size, and nesting chronology. Then protective measures relevant to the colony need to be identified including: buffers or setbacks, timing restrictions, restricted activities, and site management. Outside of the colony area, other habitats, such as foraging areas, are vital to the colony and also need consideration for protection. With these complementary components and necessary management actions defined, the management plan will provide the conservation and stewardship function necessary to support the sustainability and productivity of the target colony over time.

In 2012 the Washington Department of Fish and Wildlife (WDFW) published the updated Management Recommendations for Washington's Priority Species: Great Blue Heron (Azerrad, 2012). The WDFW Management Recommendations are based on the best available science applicable to the management of heron colonies in this region. The WDFW Management Recommendations is used as guidance for this management plan. In addition, other documents, studies, and input from regional heron experts is also utilized and cited.

It is the intent of the recommendations contained herein to provide guidance to achieve the management goals of habitat protection and supporting successful reproduction by the herons at Post Point. Implementation of the recommendations by the City of Bellingham depends on regulatory authority, land ownership, and logistical considerations

3. BACKGROUND INFORMATION

The background information provided in this section includes a regionally pertinent species summary, regulatory review of heron protection, and a detailed site description of the Post Point heron colony, including location, landuse and associated habitats.

3.1. Species and Status

The Great Blue Heron *(Ardea herodias fannini)*, is a year-round resident of the Salish Sea. Heron colonies are locations where herons seasonally aggregate to nest and reproduce, and are critically important areas for maintaining the regional species population. When not nesting, herons are scattered throughout the area and are relatively common.

The Great Blue Heron is an iconic species and recognizable by most residents of the Pacific Northwest. Great Blue Herons were named as a Valued Ecosystem Component by the Puget Sound Nearshore Partnership in 2007 (Eissinger, 2007), as a Sentinel Species by Environment Canada (Champous et al, 2002) and as part of a biological early-warning system, or indicator species, important to the human population (Wilson et al, 1996). The heron is also important culturally, both in the past by indigenous tribes and at present, by modern society.

As a resident non-migratory species, Great Blue Herons are widespread throughout the Salish Sea, particularly in coastal lowlands, wetlands, and riverine systems. Herons utilize a habitat mosaic throughout their life cycle and require a variety of suitable habitats in order to survive harsh conditions, find seasonal prey, nest, and successfully raise young. Herons forage on a variety of small prey found in marine, freshwater, and terrestrial environments, and concentrate in large numbers as food demands and prey abundance converge during the nesting season.

Heron nest sites are referred to as a colony or heronry. Heron colonies are situated within mature forests or groves, usually isolated from human disturbance. Herons utilize a wide range of tree species for nesting including both deciduous and conifer. Colonies range in size from less than 10 to over 700 nests. Most colonies are closely associated with productive feeding grounds and many are situated in coastal areas with nearby shallow intertidal habitat and abundant eelgrass meadows. Heron colonies with supporting habitats are particularly important, considering that the adult herons spend 5-7 months in the same location, and require access to nesting, resting and feeding areas with abundant prey within an easy flight distance to support both themselves and their offspring (Knight et. al. 2016). The nesting season is usually February-August depending on the colony and conditions. After nesting the herons disperse from colony sites and move across the landscape as individuals or in small groups through fall and winter.

The population and status of the Great Blue Heron population in both Puget Sound and southwest British Colombia is in the process of being updated (Eissinger and Vennesland pers. com.) From past data, the Puget Sound Great Blue Heron breeding population was estimated to be 6130 individuals in 2004 (Eissinger 2007), and 3074 for the Strait of Georgia, British Columbia in 1999 (Gebauer and Moul 2001). A preliminary review of recent Puget Sound data indicates a decline of active colonies

due to abandonment and habitat loss. Currently, the Great Blue Heron is a "Priority Species" in Washington State (WDFW 2008). Population declines in British Columbia's Strait of Georgia and Fraser Valley caused herons to be designated as a "Species of Concern" by the Committee On The Status of Endangered Wildlife in Canada (Vennesland and Butler 2004).

Factors affecting the regional heron population include habitat loss, human disturbance, environmental toxins, and depredation by predators (Vennesland 2000).

Declining habitat including coastal forests suitable for nesting, wetlands and fields for feeding and loafing is resulting from increased human development within the Puget lowlands. This situation is compounded by that fact that 73% of the colonies in Northwest Washington (including Post Point) are directly linked to and dependent on marine intertidal habitat, particularly eelgrass meadows, for foraging and require coastal areas to nest (Eissinger, 2007). Disruption and loss to vital intertidal habitats such as eelgrass is a real threat, with causes ranging from poor water quality, oil spill, sedimentation, ocean acidification and climate change, including heat facilitated pathogens causing eelgrass wasting disease (Thom and Hallum 1990, Thom et. al 2011, Mumford 2007, Eisenlord et al 2018). Human disturbance is also a factor as more people live and utilize shoreline areas and engage in water sports near the shoreline.

The loss and disruption of heron colonies by human activity has been well documented in the literature. As stated by Vennesland and Norman 2006, several studies have linked colony abandonment to human activity including residential and industrial development, highway construction, logging, vehicle traffic, and repeated human intrusions (Bjorklund 1975, Mark 1976, Werschkul et al. 1976, Simpson and Kelsall 1978, Kelsall and Simpson 1979, Forbes et al. 1985b, Vennesland and Butler 2004, Parnell et al. 1988, Rodgers and Smith 1995, Vennesland 2000). The rationale for the protection of heron colonies and associated habitat is based on the species vulnerability to human disturbance, predation and habitat loss (Vennesland 2000). Human disturbance is of particular concern due to its negative effect on productivity (Azerrad 2012).

3.2. Regulatory Review

Regulatory guidance for the protection of Great Blue Herons is provided through federal, state and local laws, legislation and landuse guidelines. Although herons are a prominent species and a vulnerable species due to their seasonal aggregations, their protection, particularly of their nest sites, is dependent on a combination of regulatory factors.

3.2.1. Federal Regulation

Great Blue Herons are not protected under the federal Endangered Species Act; however, other federal regulations apply to herons. Historically, herons and their allies were hunted for their plumes, in some cases to near extinction. By the 1880's all states had enacted wildlife laws; however only a few protected colonial waterbirds. Eventually federal law, the Lacy Act (1900) was promulgated for the purpose of controlling interstate commerce of wildlife including birds, bird parts, eggs and feathers, or unlawful wildlife trafficking.

The subsequent Migratory Bird Treaty Act of 1918 (MBTA), further protects species which migrate across international boundaries, including herons, and prohibits the "hunt, take, capture, kill or possession of any bird (or its parts, nest, or egg)" protected under the 1916 Convention with Great Britain for the Protection of Migratory Birds (Bean, 1983). In short, the Act prohibits the "taking" (capturing, killing, or collecting) of any bird, its nest or eggs. The MBTA does not protect habitat.

The list of species protected under the MBTA is periodically updated. As of December 2013, the Great Blue Heron is listed as a protected species (10.13 List) (USFWS). Provisions in the Migratory Bird Treaty Act and subsequent federal laws permit certain activities, collection or the possession of eggs or parts for scientific or educational purposes only. Permitting guidelines for the hunting, take, possession, or exportation of migratory birds are described in Title 50, code of Federal Regulations, Part 21-Migratory Bird Permits. The lead agency for all federal wildlife permits and enforcement is the U.S. Fish and Wildlife Service. Currently, a federal permit from the U.S. Fish and Wildlife Service is required by anyone anytime they intend to destroy eggs or nests; or capture, relocate, disturb or kill Great Blue Herons for damage control. Such a permit may be granted only when extreme damage is occurring and only after all other non-lethal control techniques have proven to be unsuccessful.

Although many living birds benefit from federal wildlife laws, they provide little protection for nesting areas or habitat. The Endangered Species Act of 1973 is the only federal law that governs wildlife habitat at a species specific level. Because Great Blue Herons are currently not an endangered species or a designated species of concern, the Endangered Species Act does not apply. For further questions or advice regarding federal wildlife protection, contact the U.S. Fish and Wildlife Service Office of Law Enforcement, located at 911 NE 11th Ave. Portland OR 97232 or call 503-231-6125.

3.2.2. State Regulation and Management

Washington State regulation, policies and management guidelines for wildlife and habitat is the primary responsibility of the Washington Department of Fish and Wildlife (WDFW). The Department of Natural Resources and Department of Ecology also play a role in species and habitat management.

The Great Blue Heron in Washington State is classified as a non-game species and protected under WAC 220-200-100. Herons, and their eggs and nests are protected from unauthorized taking under RCW 77.15.130.

The WDFW non-regulatory Priority and Habitats and Species Program provides biological and spatial information plus management recommendations to inform planning, permitting or conservation actions for nearly 200 species and 20 habitat types. Great Blue Herons are designated as a State Priority Species and their nesting and associated foraging habitat is considered a Priority Area.

In 2012 the Washington Department of Wildlife published updated state-wide Management Recommendations for Washington's Priority Species: Great Blue Heron (Azerrad 2012) and online at: https://wdfw.wa.gov/publications/01371. This 18-page document replaces earlier guidelines with more thorough coverage of the species life history, habitat requirements, limiting factors and other

considerations for which the management recommendations are based. The 2012 update also provides specific definitions and guidelines for urban colonies, buffers, Heron Management Areas (HMA) and Habitat Management Plans (HMP). For further questions or management advice contact the Washington Department of Fish and Wildlife Region 4 office at 16018 Mill Creek Blvd. Mill Creek, WA 98012, phone: 425-775-1311 or visit the WDFW website: http://www.wa.gov/wdfw.

Great Blue Heron habitat identification and protection may result from the State Environmental Policy Act (SEPA) of 1971. The lead agency for SEPA for the Post Point Heron Colony will typically be the City of Bellingham. Similar to the federal NEPA process, SEPA is the State's legal instrument for identifying project or action related environmental impacts during permitting and decision making stage by state and local agencies. Based on the SEPA rules, WAC 197-11, the SEPA process begins with a checklist, filed as part of the permitting process for projects or actions which includes the identification of wildlife and habitat in the project area that may be impacted. General wildlife species as well as Threatened and Endangered species are required to be addressed in the SEPA review. As a State Priority Species, the Great Blue Heron, if present needs to be reviewed for potential impacts. Following SEPA review, if the project is not exempt from SEPA rules, and the SEPA official determines that a proposal may have probable significant adverse environmental impacts, an environmental impact statement is prepared.

In 1990 the Washington State Legislature passed the Washington Growth Management Act (GMA). The Growth Management Act (SHB 2929) was enacted to ensure controlled growth in Washington's fast growing cities and counties through the adoption of local comprehensive land use plans and development regulations.

To preserve the natural environment, the Act defines environmentally critical areas with the provision that jurisdictions classify, designate and protect designated areas. There are 5 critical areas identified in the GMA, including fish and wildlife habitat conservation areas. The designation of fish and wildlife habitat conservation areas require land management for maintaining species in a wild state in suitable habitats within their natural geographic distribution so that isolated subpopulations are not created.

Pertinent GMA minimum guidelines and general requirements defining critical habitats under WAC 365-190-030.

> *Habitats of local importance include, a seasonal range or habitat element with which a given species has a primary association, and which, if altered, may reduce the likelihood that the species will maintain and reproduce over the long-term. These might include areas of high relative density or species richness, breeding habitat, winter range and movement corridors. These might also include habitats that are of limited availability or high vulnerability to alteration, such as cliffs, talus and wetlands.*
>
> *Species of local importance are those species that are of local concern due to their population status or their sensitivity to habitat manipulation….*

The Great Blue Heron as a designated Priority Species qualifies it as a Species of Local Importance under the City of Bellingham Critical Areas Ordinance.

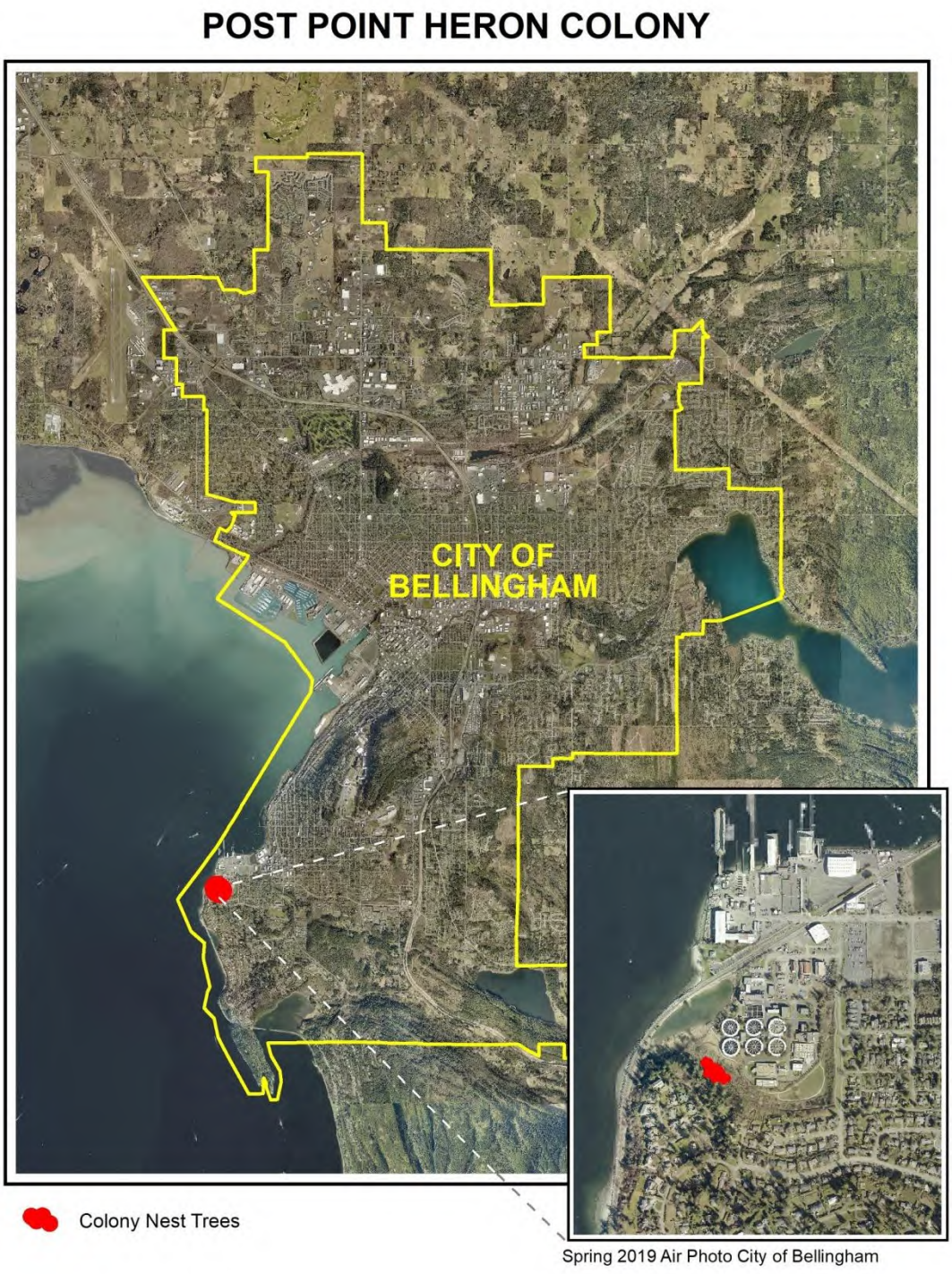
3.2.3. Local Regulation and Plans

In the City of Bellingham, local regulatory programs and policies associated with wildlife and habitat include the Critical Areas Ordinance (CAO), Shoreline Master Program, and the Comprehensive Plan. Some neighborhood plans also identify certain wildlife areas as sensitive or in need of protection.

The City of Bellingham's current Critical Areas Ordinance – updated in 2016, regulates critical areas through provisions under the Bellingham Municipal Code 16.55. Designation of fish and wildlife habitat conservation areas is defined in BMC 16.55.470 and includes: "State priority habitats and areas associated with state priority species are considered to be priorities for conservation and management." This includes the Post Point Heron Colony and associated "habitat areas."

The Bellingham Shoreline Master Program provides shoreline habitat protections within 200 feet of the shoreline. This includes heron foraging areas particularly eelgrass meadows, Post Point Lagoon and the marine shoreline habitats around Bellingham and Chuckanut Bays.

Figure 1. Post Point Heron Colony Location



3.3. Site Description and Land Use

In 2000 a group of Great Blue Herons moved to an area in south Bellingham to nest. Located adjacent to the Post Point Resource Recovery Plant formerly known as the Post Point Wastewater Treatment Plant, on City of Bellingham property, the Post Point heron colony became a point of interest by both City staff and citizens soon after it established. As a result of this interest, the City has been engaged in the documentation and tracking of the colony for 20 years and the biological monitoring of the colony for 15 years. The site specific information provided in this section is a direct result of monitoring the Post Point heron colony which has led to an understanding of the heron's habits and their habitat associations.

3.3.1. Site Description

The Post Point Heron Colony is located on the south side of the City of Bellingham known as the Fairhaven District (T37N/R2E/Section 2) (Figure 1). The colony is situated in a remnant forest 550 feet east of Bellingham Bay, near Post Point (Figure 2).

The property on which the heron colony is located is part of a 30 acre parcel owned by the City of Bellingham (Figure 2). The colony is located on the south-southwest edge of the parcel. The Post Point Resource Recovery Plant (PPRRP) occupies over half of the property and is located to the north-northeast of the colony (108 ft.), with a public off-leash dog park to the east-southeast (450 ft.), Post Point lagoon to the northwest (280 ft) and associated natural area to the east and west of the colony. To the west, separating the lagoon from Bellingham Bay and Marine Park is an active railroad causeway, 485 feet west of the colony. The publicly owned property has a public trail that follows the perimeter of the PPRRP and passes within 85 feet from the colony. Immediately adjacent to the heron colony, upslope to the south southwest and southeast, is 1.8 acres of privately owned undeveloped property, serviced by Shorewood Drive. This property is currently forested with native vegetation. The nearest residence to the colony is located to the southeast at 288 ft.

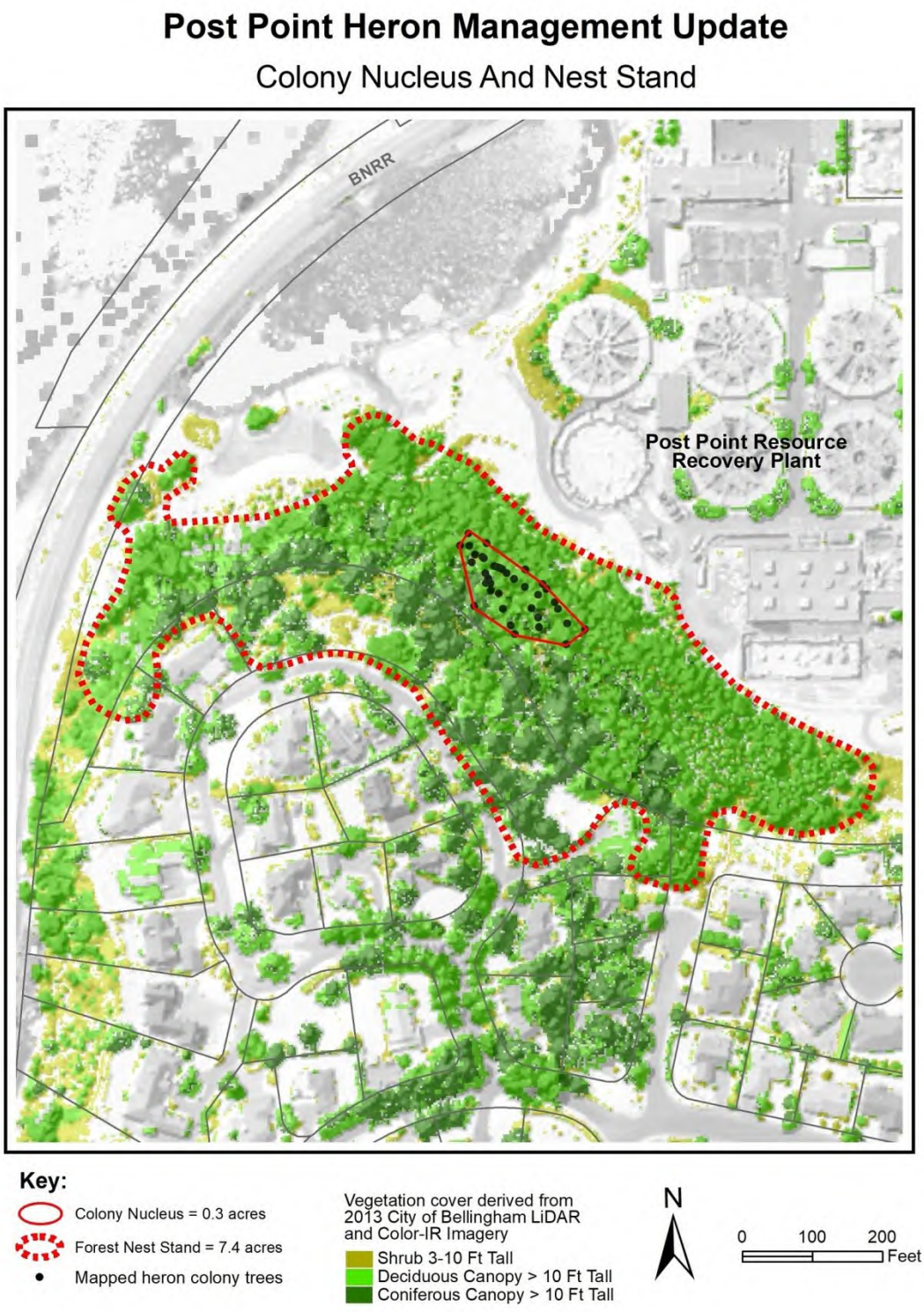
The forest or nest stand in which the colony is located spans a coastal bluff that gently rises over 100 feet in elevation, running north-south along Bellingham Bay at Post Point then turns east, or inland from the shoreline. It is on this northern-aspect inland slope where the colony is situated, wedged between the PPRRP at near sea level to the northeast and the Shorewood neighborhood upslope to the south. The forested hillside provides the heron colony separation and elevation above the public trail and nearby municipal facilities. The colony's nest trees are situated on the lower half of the slope and are surrounded by forest of various desity and height.

As of 2019, a total of 42 of nests are located in a cluster of 22 trees. The nests are located in the crown of the trees about 80 feet in height. The distance of the nests off the ground provide protection from ground predators and provides a vertical buffer from disturbance. The nucleus of the colony is that area containing nests in trees (0.30 acre) and is defined by the outer perimeter of the nest trees (Figure 3). The heron habitat is further described in section 3.4 and the colony in section 5 of this document.

Figure 2. Heron Colony Site



Figure 3. Colony Nucleus and Nest Stand



3.3.2. Landuse

The Post Point heron colony's location is characterized as urban. Land use within .25 mile of the heron colony is mixed and includes: a municipal wastewater treatment plant, park-open space, residential, industrial, commercial and marine transportation. In addition, the main coastal railroad route servicing Western Washington and British Columbia passes to the west of the colony along the marine shoreline. In this section there are 4 rails to accommodate 2 trains. The railroad is used multiple times daily by Amtrak – passenger rail service, and BNSF railway transporting freight including, lumber, coal, and crude oil.

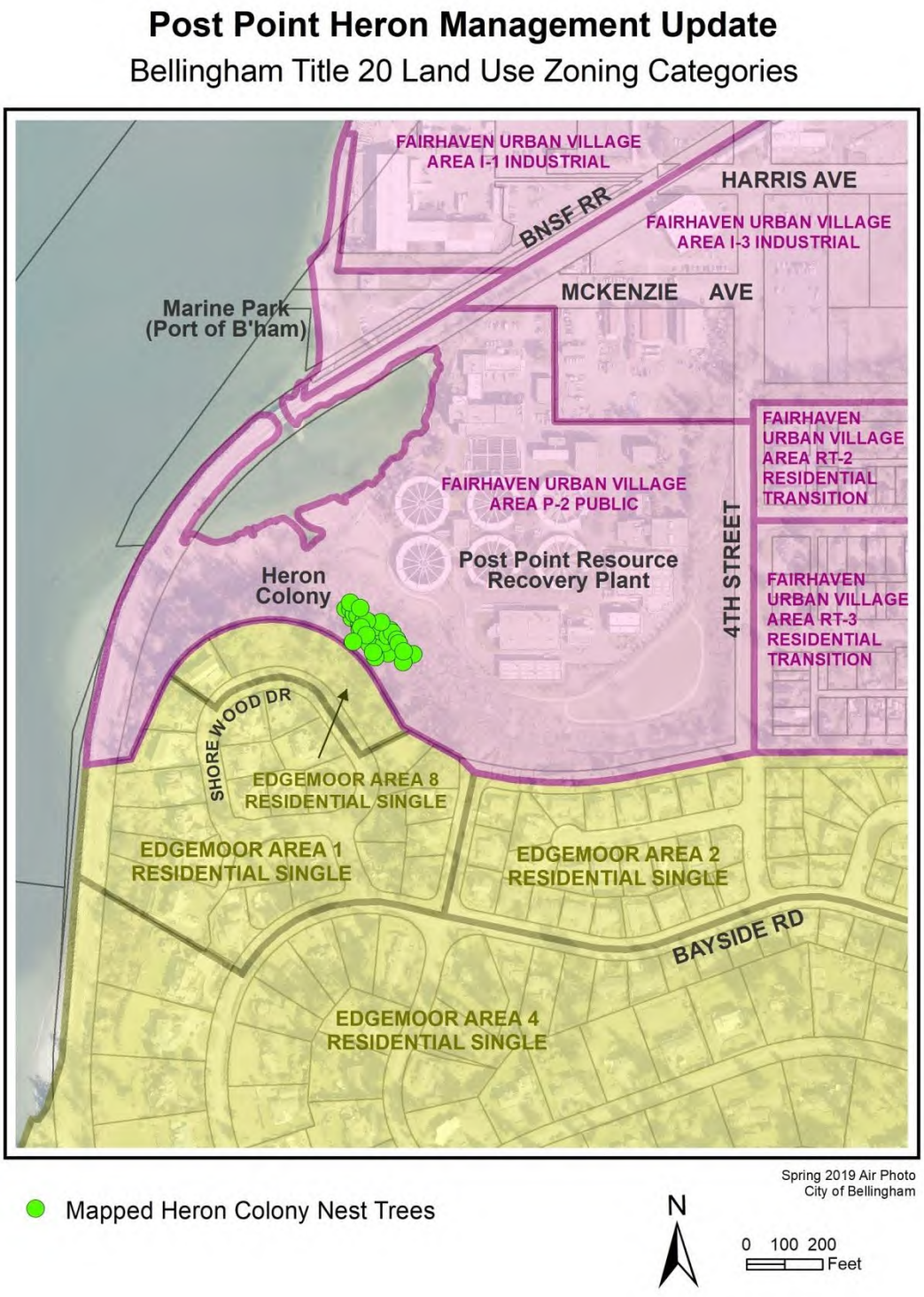
City of Bellingham zoning of the area where the colony is located is, Urban Village (Area P-2) to the north, east and west; to the south, directly adjacent to the colony, is Single Residential (COB Zoning Map 3/29/2019). The Fairhaven Plan's Urban Village Area P-2, is a Public Area designation, that includes: Padden Creek and estuary, the PPRRP, an off leash dog park, trails, Post Point Lagoon, Marine Park and the Post Point Shoreline. The Public Areas Goals and Policies in the plan specify the protection, environmental stewardship and monitoring of the Post Point Heron Colony (BMC Policy 2.24 and 2.25) (Figure 4).

The Bellingham Shoreline Master Program Shoreline designation is UC-Urban Conservancy from the Marine Park Beach south to Clark Point, defined by the BMC 22.03.030. The Post Point Lagoon is UC and also designated as a pocket estuary, which are areas of ecological value and targeted for restoration BMC 22.02.020.



Heron and young by A. Fritzberg 2011

Figure 4. City of Bellingham Zoning



3.4. Habitat Descriptions

The habitats utilized by Great Blue Herons in association with the Post Point Heron Colony has been documented over the past 20 years. Although herons may concentrate in certain areas seasonally, a mosaic of habitats is needed to support the heron population year-round.

There are five primary habitats used by the Post Point herons including:

- Coastal Forest – nest stand and roost areas
- Upland Field or Wet Meadow – foraging, loafing and staging
- Marine Shoreline – foraging
- Estuary – foraging and loafing, occasional staging
- Freshwater Systems: wetlands, lakes, streams and riparian areas – year-round use, foraging and roosting

Each habitat will be described separately. The habitats are illustrated in Figure 5

The heron's use of areas around Post Point may have multiple habitat associations. The types of use areas referred to in this document are defined as follows and are mentioned by habitat or alone.

- Colony, Nest Area, Colony Nucleus: the specific area where nesting occurs and nests and nest trees are located. Each colony varies in size and configuration depending on the numbers of breeding herons, location and available habitat. These sites are usually isolated away from human disturbance.
- Nest Stand: the forest area surrounding and contiguous with a heron colony.
- Roosting and Loafing Areas: are locations adjacent to or outside of the colony nucleus for the adults to rest, preen and depending on conditions provide sun, shade or shelter, or by young herons following their fledging from the nest. These areas can be in trees or on the ground and may be used year-round.
- Staging or Pre-Nesting Areas: sites where the herons gather prior to reoccupying nests in the colony. Use of these areas is limited to early in the season January to February or March if the season is late. Staging at Post Point is inconsistent year to year, and the location is likely weather dependant. However, one unique feature of the Post Point heron colony is their use of the PPRRP clarifiers for staging.
- Foraging Areas: sites where heron feed individually or in groups. Heron foraging areas include terrestrial, freshwater and marine habitats, where over 30 prey species have been identified (Butler 1995). During the nesting season herons may feed in large concentrations particularly in open intertidal areas.

The habitat descriptions are as follows.

Figure 5. Habitat Map

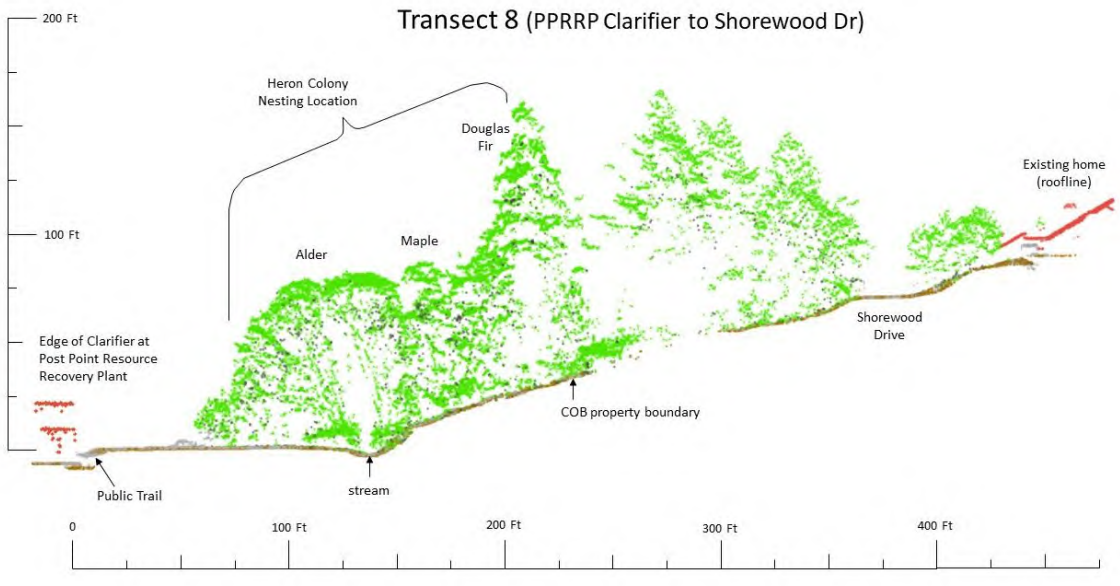


3.4.1. Forest: nest stand and roost areas

The Post Point Heron Colony is situated in a 7.4 acre forest of mixed species and ages. The dominate species include mature emergent Douglas fir *(Pseudotsuga menziesii)*, bigleaf maple *(Acer macrophyllum)*, western red cedar *(Thuja plicata),* and red alder (*Alnus rubra).* The nest trees are currently mature alder and big-leaf maple. A band of young alders have rapidly filled in along the north edge of the colony providing additional screening. Douglas fir was utilized one season for nesting., Between 2000 and 2007 native western paper birch *(Betula papyrifera)* were also present and used for nesting, but have since all died (possibly of birch blight or birch borer beetle). There are currently no birch trees remaining in this forest stand as of 2019. This forest or nest stand also includes other tree species and a mix of shrubs and forest plants. A full inventory of flora within the forest has not been conducted.

The forest area measures 300 feet wide at the colony, 350 feet at the widest point to about 90 feet at the narrowest point (variable widths) and approximately 1300 feet long which wraps around the bluff from east to west. This site is located on a slope, rising to the south about 100 feet in elevation and envelopes the heron colony on the lower half (Figure 6). The lower portion of the forested slope is predominately alder, with big-leaf maple and large Douglas fir dominating the mid and upper slope area. The upper forest on the south side of the heron colony provides wind break from prevailing winds and visual screening and vegetative buffer from the residential area along Shorewood Drive. The lower north side has a band of alders that form a thin buffer between the colony from the PPRRP. To the east and west the forest is dense and serves as a substantial buffer for the colony. In addition to vegetative buffer, screening, and wind break, the forest also creates a microclimate which moderates temperatures and the tall firs provide shaded perches.

Figure 6. Landscape Cross Section PPRRP to Shorewood Dr.



Overall the forest condition is relatively good; however, more recently some changes and disturbances have occurred in the forest and are described in section 5.5.7 of this document.

The heron's current nest area is 0.3 acres (colony nucleus), but the herons require additional forest for other activities as well as vegetative buffer and screening from adverse weather and human disturbance. Heron colony's also migrate within the nest stand and expand or contract annually which requires greater area. Although the nest stand is 7.4 acres, the minimum nest stand size recommended by WDFW is 10 acres (for alternate nest sites), which is 26% more area than Post Point. Due to this restrictive area, any loss of forest habitat could impact the colony.

In addition to nesting the herons also use the forest for, roosting, loafing and staging. These activities are concentrated during the nesting season, however herons are known to roost here year round.

3.4.2. Field and Wet Meadow

The field/wet meadow habitat component is vital to herons for foraging, loafing and occasionally staging prior to nesting. These habitats are fallow grassy areas, usually populated with small mammals, particularly voles *(Microtus townsendii),* amphibians and occasionally snakes on which herons feed. The voles provide an important winter and spring food source. Prior to the eelgrass filling in and prey becoming readily available within the marine intertidal areas, voles found in grassy fields and margins provide a nutritional boost for the breeding season.

At Post Point, there was a large wet meadow habitat area located between the heron colony nest stand and PPRRP and extending west to the Post Point Lagoon. Most of this area east of the Lagoon was planted with shrubs. The remaining habitat supports a population of voles. The grassy margins around the lagoon are utilized regularly by both young at fledging and adults for loafing and feeding. The isolated pockets of open grass also provide good sunning locations and protected resting locations during poor weather.



Grassy margins along Post Point Lagoon – wet meadow habitat

South end of lagoon



Heron loafing with mallards along Post Point Lagoon shoreline meadow

3.4.3. Marine Shoreline

Marine shorelines and intertidal areas are a significantly important foraging habitat for herons, particularly in eelgrass (seagrass) meadows where large concentrations of prey are found. Eelgrass *(Zostera marina)* is a critical component of the Salish Sea ecosystem occurring in shallow intertidal areas that are easily accessed by wading herons. Eelgrass grows in sandy and mud substrates at depths between =1.4m-12.5 meters MLLW (Christiaen et.al, 2019). If present, *Zostera japonica*, the non-native, eelgrass may occur with the native species or at slightly higher levels in the intertidal zone and serves a similar function as the native species. The microhabitats created by eelgrass form biologically rich areas with abundant prey for numerous species including Great Blue Heron (Mumford, 2007). Nearly all coastal heron colonies in the Salish Sea are directly associated with and supported by eelgrass feeding grounds (Eissinger, 2007). These feeding habitats are inextricably linked to coastal heron colonies and likely a determinate factor in the heron's reproductive success.

Although eelgrass has been surveyed in Bellingham Bay, there is not sufficient data to calculate trends, however eelgrass has remained relatively stable in Puget Sound since 2000, with the exception of declines in certain shallow beds in 2015-2016 thought to be related to higher than normal temperatures (Christiaen et.al, 2019). Sound-wide monitoring of seagrasses is extremely valuable and the City of Bellingham's support for these efforts locally provides impetus for more intensely sampled and complete monitoring (Christiaen et.al, 2019).

At Post Point, eelgrass grows both in the Post Point lagoon and outer shoreline area from Marine Park south. These areas have also been enhanced with additional planting of eelgrass in 2008. Eelgrass also occurs in larger meadows in Chuckanut Bay, Portage Island area and in patches along the Bellingham Bay shoreline.

The marine associated foraging areas for the Post Point herons in and around Bellingham Bay were surveyed and mapped in 2006 (Figure 7). Follow up surveys were conducted during the nesting season in 2007 and in 2008 detailed observations were made at Post Point and Chuckanut Bay. The primary feeding grounds observed during the nesting season included eelgrass-rich intertidal shorelines from Marine Park south, Chuckanut Bay in and outside the trestle, east side of Portage Island, Portage Bay, and Brant Island. Herons were also observed along the shoreline below Lummi Shore Drive and Marine Drive. The herons use of the Nooksack River delta is assumed, based on year-round food availability and quality habitat, but the area is difficult to survey.



Heron foraging in eelgrass at Post Point

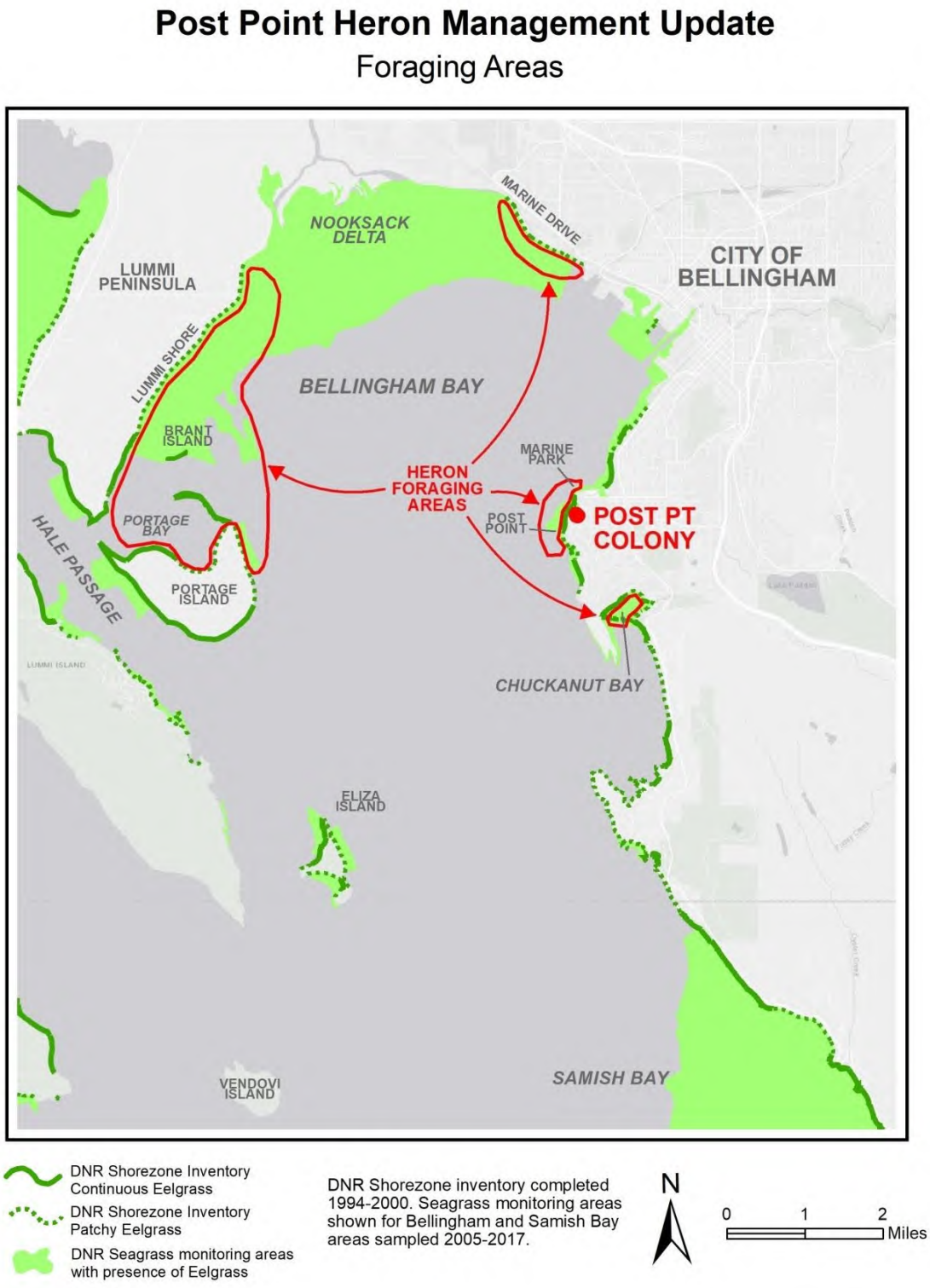
Colony proximity to foraging areas is critical to reproductive success. For example, it is estimated that 15 km or 9.3 miles is the distance at which the energetic cost of flight requires 90% of the forging intake that could be provisioned to young. (Knight, Vennesland and Winchester 2016). So, protecting the foraging areas nearest to the colony and reducing disturbance in those areas is vital to the heron colony success.

The Post Point herons travel from 0.60 to 11 miles round-trip to feed and collect food for their young (Table 1). Protecting and enhancing the foraging sites nearest to the colony has potential measurable value to the heron's productivity. Reducing disturbance at these sites is also important.

Table 1. Distance to foraging areas from Post Point Colony

Foraging Area	Distance from colony
Marine Park	0.15 miles
Post Point	0.30 miles
Portage Island	4.25 miles
Portage Bay	5.25 miles
Brant Island	4.66 miles
Lummi Shore	5.50 miles
Marine Drive	4.00 miles
Chuckanut Bay	1.40 miles

Figure 7. Foraging Areas Associated with Eelgrass



Herons optimize their feeding opportunities by following tidal stage and intertidal conditions such as gradient, channels and presence of eelgrass which vary by site location. From their central location at Post Point, herons are able to follow favorable tidal stages moving from one location to another around the bay.

Shoreline saltmarsh, and wet meadows also provide valuable feeding, staging, loafing and diurnal roost areas. Many of these pocket habitats are isolated from human activity, protected from harsh wind and weather, providing ideal hunkering sites for individual or small groups of herons. Small patches of wet meadow and salicornia dominated salt marsh areas are found around the edge of Post Point Lagoon, and both Padden Creek and Chuckanut Creek estuaries.

Shoreline or riparian forest and tree groves are valuable habitats for heron and other coastal birds for perching and roosting, which allow birds to rest, preen or vantages from which to hunt. Recognized as a valuable ecosystem component (Brennan, 2007) these features provide staging or pre-nesting gathering, and roosting habitat for herons. At Post Point, the forested area in association with the nest colony extends east and west, providing roosting and staging opportunities for herons. This forested slope historically fronted the shoreline, prior to the railroad installation. The herons utilize the Douglas fir and Sitka spruce *(Picea sitchensis)* to the west of the colony for year-round roosts. At Post Point, Great Blue Herons and Bald Eagles are frequently observed perched in fir trees at the water's edge.

3.4.4. Freshwater Systems

Freshwater systems which include wetlands, lakes, streams and rivers, are utilized by herons throughout their range and are important for providing prey, as well as roosting, loafing and in more inland areas, nest sites. Use of these systems depends on access, suitable habitat, and the lack of human disturbance.

The use of freshwater systems in the Bellingham vicinity by the Post Point herons has not been studied. However, herons, usually individuals, are observed on the shorelines of large water bodies such as Lake Padden and Lake Whatcom, certain stream segments of Chuckanut, Padden, Whatcom and Squalicum Creeks, and areas of the Nooksack River and delta. Area wetlands are also frequented by herons. These systems provide important year-round prey and habitat opportunities.

4. SITE HISTORY AND CHANGES

This section describes the site history and a summary of tangible changes based on site records and monitoring by Nahkeeta Northwest over the past 20 years. A site overview is provided in Figure 8, and a site change map is Figure 9.

4.1. Site History and Physical Changes

The Post Point site, where the colony is currently located, has been utilized for heron roosting for many years prior to nesting (Eissinger, 1995). The first nests were reported by neighbors in 1999 and may have been active earlier. The heron colony established at the current Post Point location in 2000, following the abandonment of a colony near Chuckanut Drive, due to the construction of the Blue Heron Estates development.

In September 1999, the City Council had adopted the Post Point Vegetation Management Plan for the purpose of creating views of Bellingham Bay for residential lots immediately upslope from the colony on Shorewood Drive. The Plan allowed tree and vegetation removal on City property that otherwise served as a buffer between residential uses and the PPRRP. In 2000, the City of Bellingham requested an assessment of the heron colony, and general information about herons and their management. An assessment was completed and submitted, which described the nesting area, site conditions, heron activity and recommendations for the protection of the colony (Eissinger, 2000). The City rescinded the Post Point Vegetation Plan in 2002 (Resolution 2002-07). Although the Plan was rescinded before view corridors were created, clearing of some trees and understory vegetation was allowed on the undeveloped lots on Shorewood Drive.

Recognizing the sensitivity of the Post Point heron colony, in 2001 the City of Bellingham - Department of Public Works, implemented the relocation of a public trail from its original location less than 50 feet from the colony, north to the edge of the PPRRP grounds about 150+ feet from the colony at the time. In addition, a simple wood rail fence with woven wire was also constructed through the field between the colony and the trail, to separate people and dogs using the public trail from entering the colony or causing disturbance to the herons.

In 2003, the City contracted the preparation of the 2003 Management Plan for the Post Point heron colony (Eissinger, 2003). The management plan followed guidelines from Washington Department of Fish and Wildlife, and detailed specifics about the colony, including habitat and protective measures to maintain and manage the colony and area around the colony. This plan was not formally adopted by the City, but used as guidance for stewardship of the site. In 2004, the City Council committed to continuing conservation and protection measures for the heron colony on the City's Post Point property (Resolution 2004-10). In 2005, consistent with the management plan, the City contracted with Nahkeeta Northwest Wildlife Services to conduct annual monitoring of the colony.

Between 2003 and 2012 the colony site and area around the colony remained relatively unchanged. In 2008, the City of Bellingham further implemented habitat restoration of the Post Point lagoon, including the planting of additional eelgrass took place, expanding the saltmarsh by 70%, expanding

shoreline length by 18%, restricting dog and pedestrian access to wetlands and the shoreline, and educational signs related to the herons and estuarine habitat were placed along the public trail. In 2009 an unauthorized pedestrian foot path was discovered next to the colony. The foot path cut through the heron's nest stand and skirts the colony, linking the existing public trail west of the dog-park to Shorewood Dr. The City repeatedly removed the trail and blocked access with fencing and posting signage at the trail entry points. Despite these efforts, use of the trail continues through 2019.

Between July 2012 to June 2014, the City of Bellingham Public Works Department expanded and modified the Post Point Wastewater Treatment Plant, consistent with the City's 2009 Comprehensive Sewer Plan and as defined in the City's 2011 Facilities Plan. The expansion was required for the City to comply with state and federal regulatory standards and treatment requirements for the city's growing population. This major expansion project required construction activity on the 10 acre site for 2 years and the addition of 3 new structures including a 13,000 square foot secondary clarifier with portions of the structure within 100 feet of the heron colony. This level of construction and related disturbance in close proximity to an existing heron colony was unprecedented in Puget Sound, based on known colonies 2004-2005 (Eissinger 2007).

An expansion design that fully avoided potential impacts on the heron colony was not possible due to location of the existing infrastructure. In order to mitigate impacts, the City of Bellingham, Public Works Department contracted with ESA Adolfson of Seattle to conduct a Biological Evaluation and provide a Wetland and Wildlife Mitigation Plan for the project.

A series of conditions were defined in the City's 2011 Mitigated Determination of Non-Significance (MDNS) as a means of mitigating impacts to the heronry. The MDNS is available in the appendix of the 2011 and 2012 Post Point Heron Colony Annual Reports. The MDNS included 12 mitigating conditions, for example, complete and follow a mitigation plan, work timing restriction within a 100 foot buffer from the colony between Feb. 1 and Aug. 31st (or until all the young have fledged), work within a 300 ft buffer be limited during the nesting season, monitoring of the heron colony during and after the construction, expanding the lagoon and wetland function, native plant installation, and temporarily closing the public trail during construction.

In addition to mitigation related to the heron colony, the expansion included mitigation for wetland impacts. ESA Adolfson prepared a Wetland and Wildlife Mitigation Plan for the project. Wetland mitigation for the PPRRP expansion project began in 2012. Mitigation included grading areas to enhance wetland habitat around the Post Point lagoon, native plantings, addition of large woody debris, and other steps (ESA Adolfson, 2011).

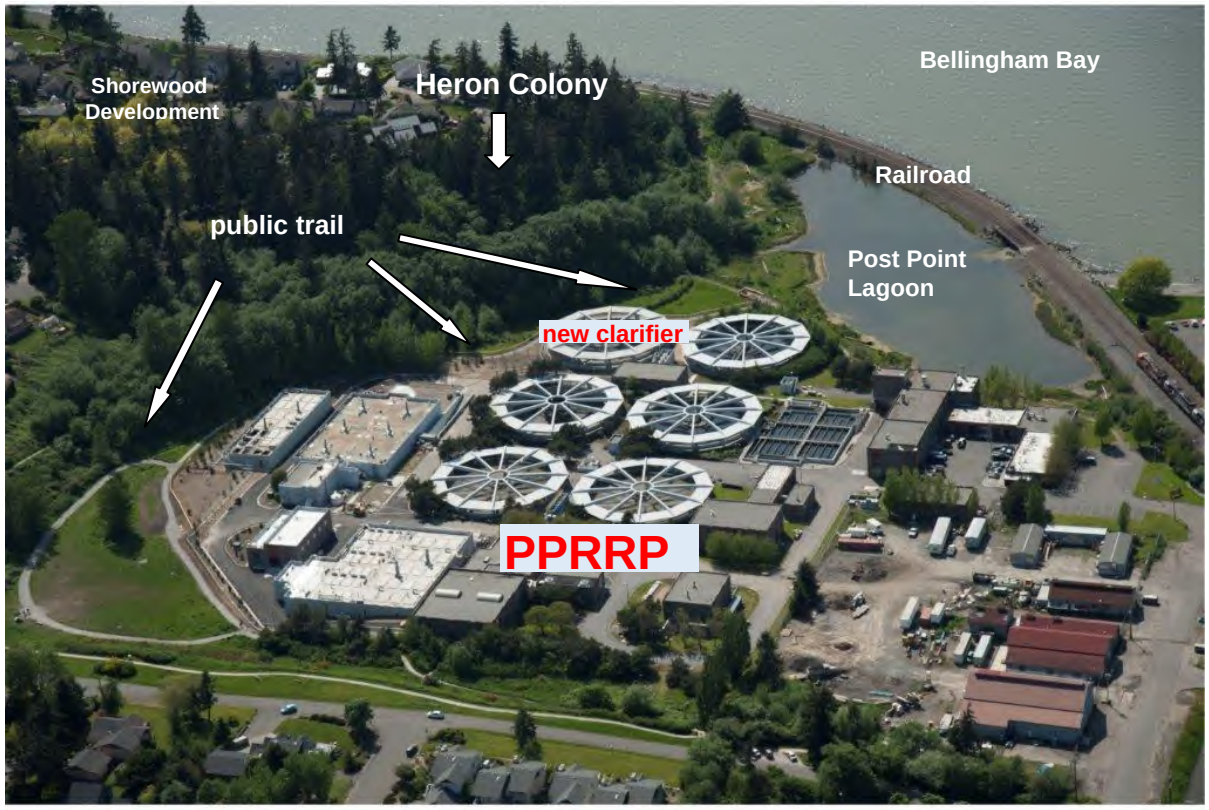
The wet meadow habitat next to the colony totaling 1 acre was reduced to .12 acre (ESA Adolfson 2011), however the mitigation for wetland loss is converting the meadow to shrubs and trees, which serve as an expanded vegetated buffer to the north of the heron colony. Mitigation for wetland loss also included removing fill, and restricting access. Mitigation activities expanded the saltmarsh by 70%, shoreline length by 18%, and re-established native marine riparian buffer. The meadow habitats around the lagoon were also altered for mitigation, but added a small salt marsh planting and grassy gaps in shrubs were maintained providing some functional space for herons, but only a fraction of the previous area. The remaining grassy area at Post Point is the off-leash dog park which

is not conducive to heron use. Overall, the habitat changes have substantially reduced the suitable meadow habitat available for heron use at Post Point.

The public trail was also moved and blocked from reaching the lagoon's south edge or continuing west to the railroad tracks, thus reducing disturbance to herons or other wildlife using that area. Replacing the trail is a viewing platform and bench with the educational interpretive signs about the herons and lagoon ecosystem. The wetland meadow below the colony was also enhanced with woody plants, essentially changing its function and eliminating use by herons, but providing future vegetative buffer and screening for the heron colony.

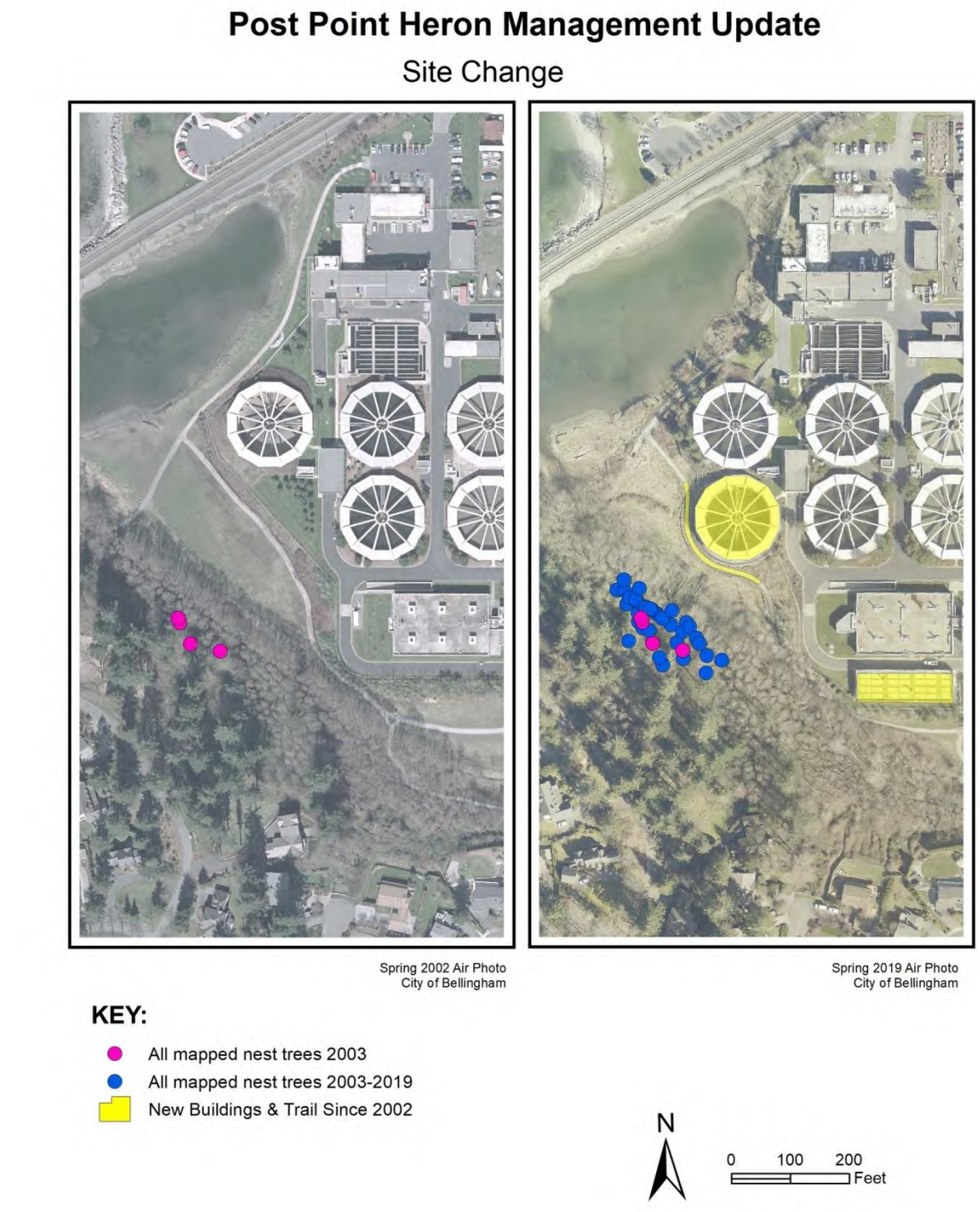
Following the completion of the PPRRP expansion in 2014, through to 2018, the Post Point heron colony and associated habitat remained relatively unchanged. Vegetation in mitigation areas grew and filled in, while the row of alders on the north side of the colony became dense and tall enough to provide screening for the colony from the PPRRP.

Figure 8. Post Point Site Overview



Post Point Resource Recovery Plant following expansion completion 2015

Figure 9. Site Changes 2002-2019



5. POST POINT HERON COLONY: HISTORY and CHRONOLOGY

Starting with the first year of nesting in 2000, the Post Point Heron Colony history has been documented by Nahkeeta Northwest Wildlife Services for the City of Bellingham. In 2005 the City began contracting Nahkeeta Northwest for formal annual biological monitoring which recorded the colony's nesting, productivity, annual chronology, disturbance and other details. Monitoring of the colony has been completed consistently each year from February 1 to the end of each season for 15 years, 2005-2019, and the results are provided in the Post Point Heronry Annual Reports which are available online. Based on monitoring the following is a summary of the colony over time.

5.1. Colony Origin

The Post Point Great Blue Heron colony is the only heron nesting site within the City of Bellingham and was first identified in 2000. The origin of the Post Point colony is from the relocation of a colony which abandoned in 1999. Known as the Chuckanut Bay colony, with about 7 nests (Eissinger, pers obs), it was located west of Chuckanut Drive and was active for several years. The construction of the Blue Heron Estates development, located directly adjacent to and in line-of-site to the nesting colony, resulted in disturbances during construction. Subsequently, the colony was abandoned in June 1999. It is confidently assumed that the herons from the abandoned Chuckanut colony relocated to Post Point.

The first account of the Post Point Heron Colony was provided to the City of Bellingham in May of 2000, following an assessment of the colony by Nahkeeta Northwest. At that time, the colony was occupied and at least 6 nests were active. The assessment provided a description of the colony, habitat and land use in the vicinity. A brief overview of the heron nesting cycle was also provided as well as an overview of WDFW management guidelines and specific recommendations for the colony. A more thorough review of the colony and site conditions was made in 2002 at which time 10 nests were occupied. The subsequent 2003 Post Point Heron Colony Management Plan was completed for the city.

5.2. Nesting Chronology

The annual nesting chronology of the Post Point heron colony is an important indicator of health and stability. The stages of nesting include: staging, colony reoccupation, incubation, hatching, fledging, and dispersal The Post Point Heron Colony annual reports identified timing for each of these nesting stages which, when viewed over time, can be informative and provide the bases for setting timing restrictions and other management guidelines.

One unique feature of the Post Point Heron Colony is their use of the PPRRP clarifiers to stage prior to nesting. Staging is a poorly understood behavior in which early arrivals to a colony will gather nearby for a number of days or weeks prior to entering the nesting area and begin breeding. This behavior has been observed at Post Point over multiple years. The herons also will utilize the lagoon edge or roost areas including the colony area prior to engaging in nesting activities.

The arrival of herons to the colony or general vicinity is usually in late January or early February. Reoccupation of the colony and the onset of nesting ranges from February 9 to March 21. Weather influences the herons' arrival and the onset of nesting. The herons were either delayed in arrival or temporarily forced from the colony early in the season due to late winter storms for 6 of the 15 years. Between 2017 and 2019 freezing temperatures, northeast winds and snow have delayed nesting into mid to late March. The latest reoccupation was 2019, on March 19.

The onset of incubation is determined by heron behavior and is an estimate due to potential confusion with egg laying. Incubation has occurred between March 12 and April 1, except 2019's late incubation on April 9.

Hatching of young occurs following 28 days of incubation, and detection is by discarded egg shells and/or young vocalizing in the nest. Due to asynchronous egg laying, hatching may require up to five days per nest. In the event of failure or depredation of eggs or newly hatched young, the season could be extended while the heron lay a second clutch or the nest could possibly fail. The dates of hatching have ranged from April 15 to May 9.

Young require 8 weeks to reach fledging age, at which time they generally leave the nest. The onset of fledging has occurred from June 17 to July 20. For several years the peak fledging has occurred the first or second week of July.

The end of the nesting season depends on all the nests completing their fledging of young and dispersal from the colony. Late arrivals to the colony or second clutches due to predation cause later fledging and dispersal dates. End of season dates range from July 12 to August 26.

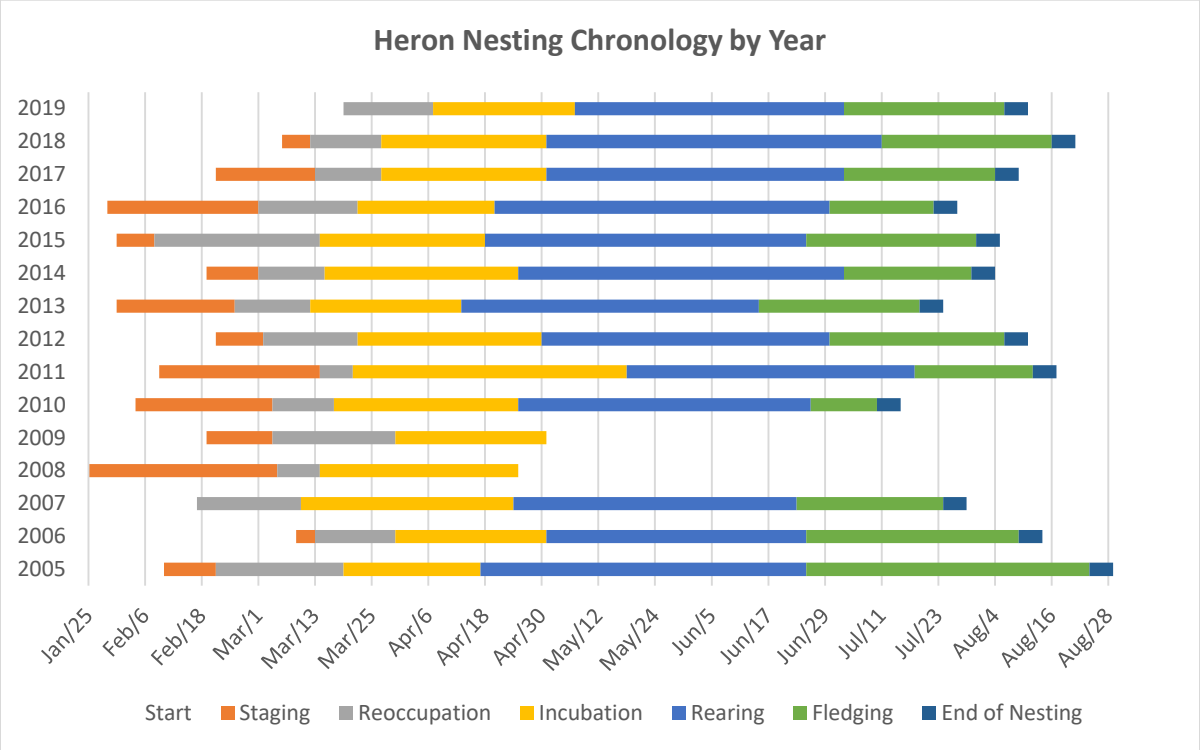
The total duration of the nesting period at Post Point in 2019 was 20 weeks total. Previous nesting periods include:

- 2018 = 22 weeks
- 2017 = 17-18 weeks for most nests up to 23+ weeks total
- 2016 = 22 weeks, which does not include the initial 2 week occupancy, followed by the 2 week desertion of the colony in February
- 2015 = 25 weeks
- 2014 = 22 weeks
- 2013 = 19 weeks (PPRRP expansion)

Based on the chronology of the Post Point Heron Colony over the past 15 years, as described and illustrated, the nesting or breeding season of this colony for management purposes is January 15 to September 1. These dates are framed by the earliest return for the herons and the latest departure with the addition of a few days at the beginning and end to account for potential variation.

The annual nesting chronology is illustrated in Figure 10.

Figure 10. Post Point Nesting Chronology 2005-2019

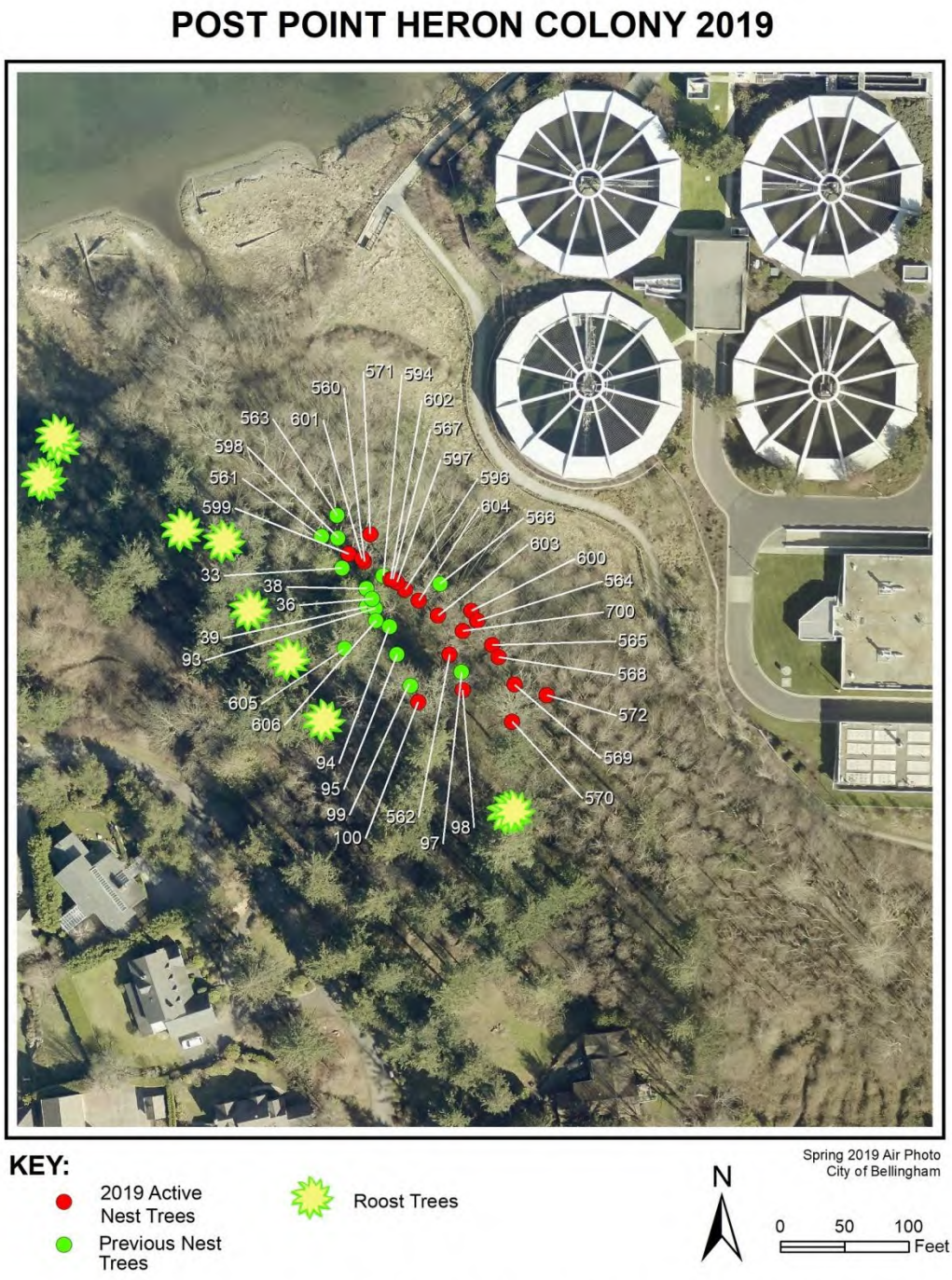


5.3. Nests and Nest Trees

The Post Point Heron Colony consists of large stick nests situated in the crowns of alder and big-leaf maple trees about 80 feet in height. The distance of the nests off the ground provide protection from ground predators and provides a vertical buffer from disturbance. Some trees hold multiple nests. All nest trees have been marked (tagged), assessed, number of nests recorded and mapped. This inventory is updated annually. Mapping of the colony is conducted by the City of Bellingham GIS Services. An illustration of the nest tree map for 2019 is in Figure 11.

The assessment of nests and their use is also recorded. The total number of nests in a heron colony is generally used to indicate colony size for any given year. However, if nests are not used, that number can be misleading. Therefore, the number of active nests is a more accurate representation of actual colony size. Active nests are those that have been occupied by a pair of heron during all or part of a nesting season. The number of successful nests, represent nests that fledged young. The number of nest trees or trees that hold one or more nests, reflect nest concentration. These values, combined with productivity, timing, heron behavior and nest location, if tracked over time, effectively indicate the dynamics of the colony.

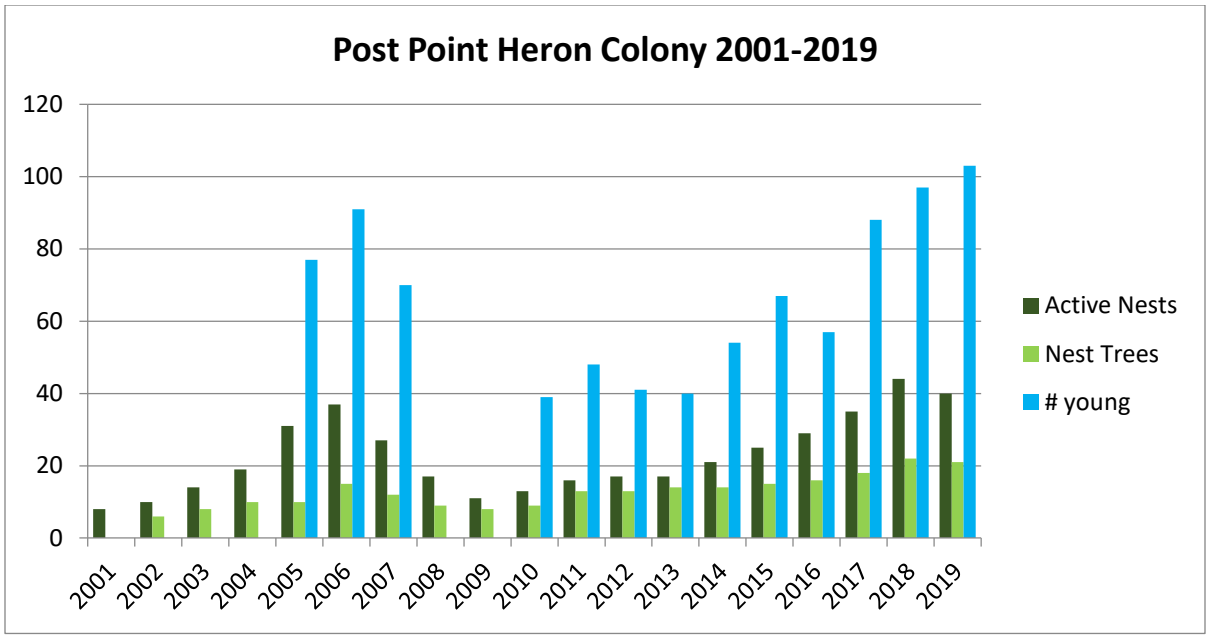
Figure 11. Post Point Heron Colony Nest Trees by Tag Number



Note: 28 of 38 tagged tree locations have been located by PW Survey staff in 2013 and 2018. Six additional trees (2014-2019) were located in the field by Nahkeeta NW and/or City Planning staff by triangulating between previously-mapped trees. Four historic nesting trees that have since blown-down or been damaged are represented with last known location.

A summary of the colony total nests, nest trees and young per year is illustrated in Figure 12.

Figure 12. Total Nests, Nest Trees and Young Per Year



A part of the annual colony inventory is tree health and condition. Health and condition of the nest trees is assessed visually and recorded. Beginning in 2002, the colony nest trees seemed to be healthy and protected from wind throw as little storm damage was recorded through 2006, with the exception of some winter nest loss. The colony also appeared to be protected from prevailing south winds due to a combination of topography and vegetation, including tall firs providing a wind break.

However, in 2007 a winter storm blew down 5 birch trees and damaged 1 alder. All of the trees were tagged and had been active nest trees at one time. One of the birch was already dead, and another in poor condition, but both still used for nesting. It is possible that those trees were diseased since no birch remain or have since regenerated in the nest stand. Following the loss of the birch nesting trees the herons have concentrated their nesting primary in alder, and big-leaf maple, and occasionally in Douglas fir.

More recently, in 2018-2019 significant tree mortality occurred in the colony and nest stand. Storms and high winds blew down and broke off a few nest trees and many trees in the northern buffer. In addition, 4 nest trees died from unknown causes in 2019. All of the damaged or dead nest trees were large mature alders, with no previous indication of poor health or condition. Over all, a total of 36 trees were lost, creating a gap in the colony and nest stand from the public trail to Shorewood Dr. (see photo in section 5.5.7). A more detailed description of the storms and tree wind-throw is provided in section 5.5.7.

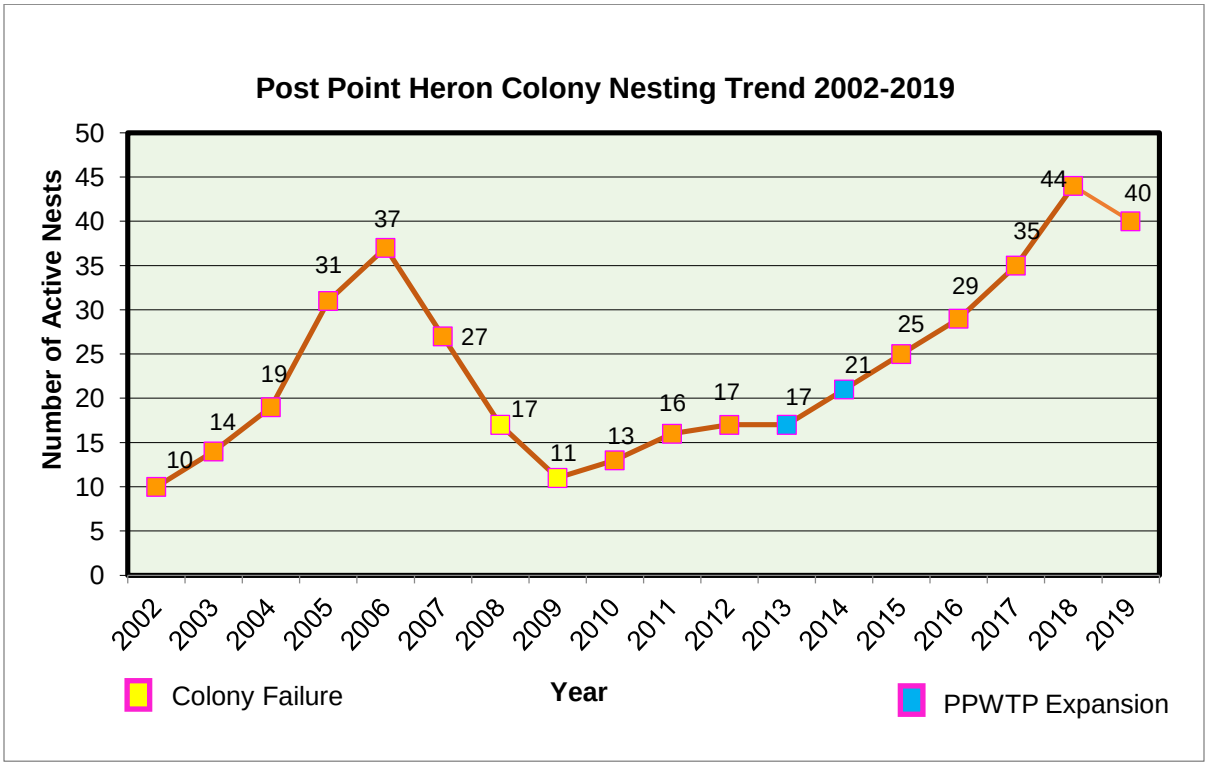
A visual evaluation of the tree loss was made by Nahkeeta Northwest in the fall of 2019, and no obvious sign of disease, insect infestation or tampering was detected. Further evaluation by a professional arborist is needed.

5.4. Colony Success, Growth and Productivity

The Post Point Heron Colony has experienced fluctuations in its success, growth and productivity. Success is measured by the number of young successfully fledged. Growth is based on the number of active nests representing nesting pairs. Productivity is gauged by the number of young per nest.

The success of the colony has been relatively good. The colony failed 2 seasons out of the 19 seasons of data collection. The failure occurred midseason in 2008 and 2009. The cause of nest failure was related to Bald Eagle depredation. Unlike many failed colonies that have suffered severe depredation, at Post Point the herons returned to the colony to nest in 2010, and have continued to return each subsequent year to nest to present. This demonstrates the resilience of the colony and strong site fidelity of the adult herons returning to Post Point.

Figure 13. Post Point Annual Active Nests



Overall the Post Point Heron Colony has grown from 10 nests in 2002 to a high of 44 Nests in 2018. However, the colony's growth has not been a linear trajectory. As illustrated in Figure 13, the colony has experienced growth during 2 time periods 2001-2006 then 2010-2018. Between 2007-2009 the colony experienced increased Bald Eagle depredation and subsequent failure in 2008-2009. Although the colony rebounded in 2010, fewer heron returned and growth resumed at a slower

pace. In 2017, a nearby large heron colony (Samish Island) abandoned and it is assumed that the growth in 2018 was in part a result of the relocation of some displaced herons.

The productivity of the Post Point Heron Colony has been excellent – averaging 2.5 young per nest between 2013-2019. The colony's productivity is above the normal range for this region based on published data; the comparable references include 1998-1999 averages for south-coastal of British Columbia which range from 1.24 per active nest to 2.15 per successful nest (Butler and Vennesland 2004) and 2000 averages in King County of 1.77 per active nest and 2.42 per successful nest (Stabins et.al. 2006). Based on these figures, mean productivity is 1.5 per active nest and 2.28 per successful nest, less than the 2.5 of Post Point.

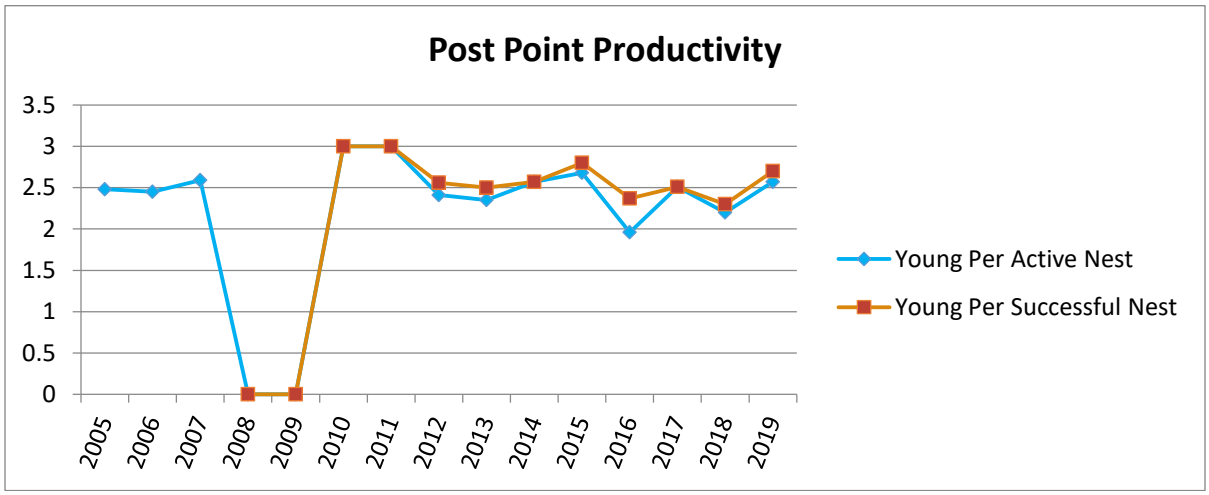
Table 2. Post Point Productivity 2013-2019 – based on all active nests

Year	No. active nests	No. successful nests	No. young	No. young per active nest
2019	42	38	104	2.47
2018	44	41	97	2.2
2017	35	35	89	2.5
2016	29	24	56	1.96
2015	25	24	67	2.68
2014	21	21	54+/-2	2.57
2013	17	16	40	2.35

Note: prior to 2013 productivity was based on a sample of nests.

The difference between active and successful nests at the Post Point Heron Colony is negligible for most years, Table 2 and illustrated in Figure 14. In 2016, herons in the colony were exhibiting agitation for unknown reasons, which may have contributed to the lower productivity for that season.

Figure 14. Post Point Heron Colony Productivity 2005-2019



Note: the Post Point heron colony was active but abandoned mid-season and failed to fledge young in 2008 and 2009.

5.5. Colony Disturbance and Disruption

Disturbance to heron colonies is the primary cause of reduced productivity, colony failure or abandonment (Rogers and Smith 1995, Vos et al. 1985, Vennesland and Butler 2004, and others). Disturbance is defined as an adverse behavioral and/or physiological response from at least one individual (Sutherland 1996, Walker et al. 2006 *in* Vennesland 2017). Documented disturbances or disruptions are generally from 2 primary sources: natural and human. Natural causes include predators – primarily Bald Eagle, adverse or extreme weather events, fire, and disease.

Human caused disturbances range from human activities near or intrusion into heron colonies, habitat removal or alteration, shooting, low-flying air craft (manned and unmanned), boats, noise, and toxins. Disturbance of nesting herons by humans is well documented (Bowman and Siderus 1984; Gibbs et al 1987; Vos et al 1985; DesGranges 1989; Kelsall 1992; Carlson and McLean 1996; Skagen and Melcher 1996). Documented human related disturbance of heron colonies range from direct human incursions into the colony, discharging of firearms, loud sudden noise from machinery, vehicular incursion, boats and aircraft. Herons are least tolerant of disturbance during courtship and the early nesting period (Kelsall and Simpson 1979; Bowman and Siderius 1984; Forbes et al. 1985; Vos et al. 1985). Abandonment of colonies resulting from repeated incursions or combined disturbance factors has occurred. Of 38 cases of colony abandonment, Forbes (1985) reported that 82 percent were related to human disturbance.

Any natural or unnatural disruption to the colony or cause of stress, changes in normal behavior, or flushing from nests, roosts or feeding grounds is considered a disturbance. In some cases, intentional human-caused disturbance would be considered harassment and could be an enforceable offense (RCW 77.15.130) .

Predicting a colony's tolerance for disturbance is difficult. It is acknowledged by the 2012 WDFW guidelines that *"we do not know the threshold for threat or disturbance resulting in suspension of nesting or abandonment of a heron colony."* New activities should not add to the intensity of disturbance a colony has historically adapted to (Azerrad 2012). This would include new homes located closer to the colony than current conditions. New residential development places humans and their pets even closer to the colony with little controls. Noise, lighting, vegetation alteration, use of pesticides and the potential for incursions into or close to the colony are all possible disturbances.

A more thorough discussion of disturbances and related studies is provided in the 2003 Post Point Heron Colony Management Plan: Disturbance Reduction. Most importantly is the fact that repeated disturbances may result in the impairment of a colony, so enforceable actions to prevent or limit disturbance to a colony are necessary for long term protection.

The City of Bellingham contracts with Nahkeeta Northwest Wildlife Services to monitor the Post Point Heron Colony and recording disturbances is a component of that monitoring. Any observed or reported loss of heron, young, or eggs, or repeated disturbance to the colony or feeding area are documented by the on-site monitor, and the City explores remedies to counter the disturbance and implements remedies where possible. Unfortunately, weekly monitoring is usually inadequate to

witness disturbances in real-time, so monitoring is often supplemented by reporting by neighbors, citizens and PPRRP staff.

Over the past 20 years the herons of Post Point have experienced numerous disturbances and disruption. The behaviors of the herons provide the best indicator of disturbance, with the extreme response resulting in flushing from nests, roosts, or feeding grounds, and the ultimate negative affect resulting in the evacuation of the colony, all of which has been documented. Although the herons have demonstrated resilience in the past, and have returned to the colony each season, there is a tolerance threshold that when reached will result in the loss of the colony. Unfortunately, there is no way to forecast a colony's threshold for threat or disturbance resulting in the suspension of nesting or abandonment of the colony (Azerrad 2012).

The following are summaries of disturbances and disruptions which have occurred at the Post Point heron colony.

5.5.1. Bald Eagle and Other Predators

Bald Eagles *(Haliaeetus leucocephalus)* also impact some heron colonies. A rebounding Bald Eagle population has played a role in heron colony disruption by preying on eggs and young. Eagle incursions adversely affect heron productivity in certain colonies (Norman, et. al. 1989, Vennesland and Bulter 2004). More aggressive eagles also threaten and prey on adult herons, although this is rare. However there is also clear evidence that Bald Eagle nesting in or near a heron colony has a beneficial effect on the heron colony productivity because the resident eagles repel other eagles away from their nest territories, thus limiting the depredation to the colony (Jones, Butler, Ydenberg 2013).

During each monitoring visit to, and in the vicinity of, the Post Point Heron Colony, observations are made of potential predators, primarily Bald Eagles.

Bald Eagles have been known to directly disrupt the Post Point Heron Colony. Eagle incursions into the heron colony occurred in 2005, and in 2008 and 2009 eagle depredation is thought to be the reason for a mid-season colony evacuation. In 2010, no incursions occurred. In 2011 eagle depredation caused some herons to re-lay eggs, after their first clutch was consumed or damaged. In 2012 only 1 eagle incursion was reported, and from that point through 2019 no Bald Eagle incursions into the colony have been observed or reported.

In 2006 a pair of Bald Eagles built a nest in a large Douglas fir approximately 62 feet south east from the heron colony. The nest was active in 2006 and possibly 2007, 2008 and 2009, after which there was no activity. In 2013 another active Bald Eagle nest was identified on Hawthorn Rd. approximately ½ mile southeast of the colony. The new nest location relative to Post Point is illustrated in Figure 15. This nest site was active from 2014-2016. No nesting has been observed or reported from 2017 to 2019.

Aside from acting as predators, Bald Eagles generally co-exist with herons. Bald Eagles are relatively common near the Post Point heron colony. One or occasionally 2 adult Bald Eagles regularly perch above the colony or to the west in large emergent Douglas Firs. The eagle's presence roosting near the colony does not disturb the herons or disrupt their nesting activities. Interestingly, the resident

eagles appear to ignore the herons and do not raid the colony. When incursions do occur the eagles are many times sub-adult and act opportunistically.

The status of Bald Eagles in this region is not known, due to the discontinuation of Bald Eagle monitoring by WDFW. A Periodic Status Review for the Bald Eagle in Washington indicated that the population has continued to grow through 2015 (Kalasz and Buchanan 2016). Due to the success of the Bald Eagle population and its rebound from near extinction in the 1960's and 70's, the species was delisted from the Federal Endangered Species Act in 2007, followed by down listing to "Sensitive" in Washington State in 2008. However, Bald Eagles and their nests, remain protected under the Bald and Golden Eagle Protection Act (federal), and under the Washington State Bald Eagle Protection Rules (WAC 232-12-292) and local Critical Area guidelines.

Other predators have not been observed as antagonists in the heron colony. Northwestern Crows *(Corvus caurinus)* have been known to enter the colony following Bald Eagle incursions, presumably to scavenge on the spoils, and crows nest near the colony without conflict with the herons. Red-tailed Hawks *(Buteo jamaicensis)* and Ravens (*Corvus corax)* have been observed flying over the colony and may stop at the nest stand, but have not been observed causing any disturbance. These predators were also found to have little impact on heron colonies in south-coastal B.C. (Vennesland and Butler 2004).

Figure 15. Bald Eagle Use Areas



5.5.2. People and Dogs

One of the questions raised when colony monitoring began in 2005 was – will the off-leash dog park and/or public trail used by people and dogs disturb the herons or disrupt the colony? Since monitoring began, the City of Bellingham has moved the dog park further from the colony, relocated the public trail further to the north, installed protective fencing, and installed protective signage (please see Site History and Chronology, above). The dog park is currently located 450 ft. from the colony to the western trail junction of the dog park. The dog park is visually screened and partitioned from the colony with dense forest and vegetation. Although the park is used nearly continuously during daylight hours there has been no conflict with the herons. Herons have shown no response during monitoring visits to people or dogs in the off-leash area, including active dogs playing and loud barking.

The public trail is also well used, and the herons appear to be adapted to the movement of people and dogs on leash. The public trail continues from the dog park west through a forest patch into a field about 85 ft. north of the colony. To maintain physical and visual separation from the colony, the trail is well fenced to contain off leash dogs, plus, there is a dense row of alder providing visual screening, except for one section of buffer that blew down in 2019. The height of the nest trees, about 80 ft., also serves an important function to create vertical separation or added buffer from the ground to the nests.

Human activity in and around the Post Point Waste Water Treatment Facility appears to have little effect on the nesting herons. During the late winter herons have regularly staged on the clarifiers at the PPRRP and were occasionally flushed by plant personnel, however, this did not deter the herons from returning.

Where herons, people and dogs do not mix, is in the nest stand and on the feeding rounds. People camping and an unauthorized pedestrian trail within the nest stand near the colony have occurred over the years. These situations are both likely disturbances to nesting herons and could result in nesting disruption or abandonment.

On the Marine Park beach south to Post Point is a popular area for public shoreline access. At low tide, heron feeding in the intertidal areas are vulnerable to people and/or off leash dogs that approach the herons too close and flush them from the beach. This situation is a clear disturbance and if repeated will cause the heron to relocate to feed costing time and energy and ultimately has a negative effect on both the adult and young in the nest.

5.5.3. Railroad - BNSF

The railroad causeway to the west of the colony is frequently used and is noisy. Railroad train traffic has increased substantially over the past decade, with increased frequency and longer loads, both day and night. Train horns have also increased in frequency and have been measured at 85.8 decibels (dB) at the colony, while the average ambient noise level at the colony is 55-60 dB. In addition to the horns, is the loud noise of the trains on the tracks, screeching breaks, vibration and exhaust fumes. Due to the close proximity of the heron colony to the railway, the cumulative disturbance by the trains could negatively affect the heron colony and reproduction, however to date productivity remains stable.

Direct train related disturbance to the herons has been observed on the shoreline as trains have approached. Both the approaching train and sounding of its horn disturb herons near the tracks. The disturbance caused the herons to flush from their feeding grounds. Some heron return to feed, others leave the area.

Maintenance and repair of the Post Point trestle took place in February-March of 2017. The noise from construction activities was measurable, with decibels reaching 80 dB in the colony, which is about 18 dB above the average ambient sound level at the colony. Although the noise from the railroad maintenance was well above ambient levels, there was no observed disturbance to the heron colony.

5.5.4. Post Point Resource Recovery Plant (PPRRP) Expansion

In close proximity to the heron colony, the Post Point Resource Recovery Plant (PPRRP) expansion was a major construction project that ran 2 years from July 2012 to June 2014. The project involved plant upgrades for regulatory compliance as described in Section 4.1. The scale of the project, magnitude of the noise, level of activity and close proximity to the heron colony would be defined as an extreme disturbance.

Mitigation, as defined in the City's MDNS for the anticipated project disruption, included a 100 foot heron colony no-disturbance buffer (actual measurement = 150 ft. from the nearest nest tree) a timing restriction of February 1-August 31 for construction of the clarifier or any other activity within the 100 ft. buffer. Plus, a secondary buffer of 300 ft. from the colony, redirected work during the nesting season to concentrate inside the built facility and its partially screened perimeter. There was also instruction to limit noise and lighting from construction. During the project there was a daily workforce of 30 to 80 construction personal, multiple pieces of heavy equipment running simultaneously, including trucks coming and going, and 2 construction cranes ranging in height from 80 to over 100 feet that were periodically moved around the grounds where needed. As a result, the construction activity and related noise was high at peak periods.



Post Point Wastewater Treatment Plant Expansion 2013 – A. Eissinger

During the construction of the PPRRP expansion, the City of Bellingham contracted with Nahkeeta Northwest to closely monitor the heron colony (twice weekly) for changes in behavior or other signs of disturbance. Weekly reports were provided to the project supervisor. In addition to heron observations, noise levels were informally recorded at the base of the colony's northeast edge at ground level. These levels are measured in decibels (dB) and ranged from a low ambient level of 57 dB, to a high level of 97 dB. Generally on-site sound levels range from the mid-60 dB to low-90 dB. The greatest noise levels occurred during combined construction activities using heavy equipment, drilling and dumping of materials (rocks). High noise levels were also recorded for trains passing and low flying aircraft.

The duration of the project ran through only 2 heron nesting seasons (2013 and 2014), due to the project startup in 2012 following fledging. Also, by the onset of nesting in 2014, much of the heavy construction had been completed, with finish work underway until June.

No extreme responses to construction disturbance, such as flushing, were exhibited by the herons, although there were changes in nesting behavior. The results of heron monitoring included the lack of staging early in the 2013 season, the lack of normal roosting and loafing aggregations of heron within the colony, and the heron's broad flight avoidance of cranes. The lack of regular Bald Eagle activity may also have been influenced by the construction and related disturbance. The heron colony remained at the same size in 2013 as it was in 2012, and grew by 4 nests in 2014. Colony nest productivity for 2013-2014 remained within the normal mean of 2.5 young per active nest.

One notable difference between 2013 and 2014, was the more relaxed nesting season in 2014, opposed to the notable change in behavior and abbreviated nesting season in 2013. Normally, herons at this site are in the colony nesting over a period of 21 to 25 weeks. In 2013, the heron were in the colony only 19 weeks total.

Following the completion of the Post Point Wastewater Treatment Plant expansion in 2014, close attention was paid to the heron's response to the alteration of habitat, new clarifier and associated public trail, both located within 100 feet of the colony. Over the past five years, no obvious disturbance or negative reaction by the herons has been noted. However, since 2014 the monitoring biologist has noted a strong chemical odor from the PPRRP. We recommended this odor be evaluated to determine the cause and potential effects on the heron colony.

5.5.5. Ski to Sea

Every Memorial Day weekend an international competitive event, the Ski to Sea Race, finishes at the Port of Bellingham's Marine Park and stages associated festivities in Fairhaven. This one day event includes a multi-leg relay race involving about 350 teams and 1000 volunteers. As a result, the Marine Park area at Post Point is inundated with people, temporary structures and equipment on race day. The activity is concentrated on the shoreline and Marine Park site located about 700 feet northwest of the heron colony.

Nahkeeta Northwest has conducted monitoring during the event of both the heron colony and heron feeding along the marine shoreline. Results of observations conclude that the heron colony has been unaffected by Ski to Sea due to the colony's distance from the activities at Marine Park

and the lack of noticeable increase in use of the public trail or dog park near the colony; also the PPRRP provides a physical buffer between some of the event activities and the colony.

However, during Ski to Sea hundreds of race-day fans gather on the shoreline, or in boats, to observe the completion of the race as participants paddle sea kayaks to shore then run to the finish line. As a result, disturbance to herons foraging along the shoreline or displacement is nearly unavoidable, unless the tide is high at the time of the event or if the beach were to be partitioned with a temporary barrier south of Marine Park to allow the herons an undisturbed area to feed.

In 2019 the City took additional steps to minimize conflicts between the Ski to Sea event and the Post Point Heron Colony. These efforts were in response to recommendations provided in Nahkeeta Northwest's 2018 annual monitoring report. The City coordinated with the Port of Bellingham, park owner, to post temporary signs at Marine Park and Post Point Lagoon asking citizens to keep their distance from herons and avoid flying drones over the heron colony and foraging habitat. The City also worked with the Ski to Sea organizers and the Bellingham Herald to confirm they would avoid drone use over these same areas.



Ski to Sea Finish Line Marine Park 2016 photo by Tami DuBow

5.5.6. Aircraft and Drones

Low flying aircraft such as helicopters have been reported flying over the Post Point heron colony. Although no direct disturbance to the heron colony has been observed or reported there is concern that the noise and/or downwash from a low flying helicopter could flush adults or young out of nests or dislodge nests.

Drones continue to be of concern. In 2016, individuals flying drones were observed at Marine Park. Drones were also used in this area in 2017 for aerial photography. Drones may be considered a source of intentional harassment if flown in sensitive areas such as heron colonies when herons are present and are repeatedly disturbed (RCW 77.15.130).

5.5.7. Weather

Annual monitoring of the colony has documented weather as a cause of disruption to the herons and their nesting cycle. Late winter storms, high wind events, uncommonly high and low temperatures, heavy rain, hail, snow and periods of drought have all been recorded, some of which have been record setting. Weather events that could influence the herons are generally summarized or described in the Annual Reports.

Severe late winter storms have become a regular disruption for the heron colony. Beginning in 2011, late winter storms in February have occurred 6 out of the past 9 seasons. The storms vary in onset, duration and intensity, and include strong northeast winds, sub-freezing temperatures, snow and ice. The observable effect of the storms on the heron colony is to either delay the herons reoccupation of the colony or in some cases force the herons out of the colony temporarily to wait out the harsh conditions. The worst storms have occurred 2017, 2018 and 2019. During all 3 years the herons have delayed their nesting, and in 2018 and 2019 the herons did not return to the colony until March. The latest delay due to late winter weather was in 2019, with nesting setback until March 21. Other than the delay to the onset of heron nesting, the storms did not appear to impact the heron's reproductive success.

For much of the past 20 years, the effects of wind or storms have had little impact on the nest stand or nest trees. Generally, the heronry at Post Point is protected from south-southwest winds due to topography, and a band of forest vegetation upslope with tall firs extending west to provide wind break, and although the colony is somewhat exposed to northeast winds, not at full force. However, in 2007, and particularly in 2018-2019, wind storms did cause damage to the colony and associated forest habitat.

In 2007 all of the birch trees that were used for nesting were lost by wind and possibly a pre-existing disease. No birch remain in the nest stand today.

More recently, there has been notable tree mortality in the nest stand and colony. A total of 36 trees have blown down, broken off, or died. From early 2018 to September 2019 there was the loss of 29 alders along the northern edge of the colony, as result of wind throw; the trees were up rooted and fell in clumps to the north (majority 30 deg N, with fewer at 338 deg NW and 15 deg N.). This is illustrated in Figure 16 and the photographs below.

Nest trees were also affected by the storms. In early 2019, 4 nest trees did not leaf out and were determined to be dead. During a storm in September 2019, one nest tree blew down that was already dead, and 3 nest trees were broken off, indicating a high velocity south wind striking the colony.

Due to the history of storms and the previous lack of tree damage in the colony or nest stand, the scale of tree loss in 2018-2019 was unprecedented. These losses have impacted the heron colony by removing well used nest trees, creating a gap through the center of the colony and nest stand, and reducing screening of the colony to the north, exposing a portion of the colony core to the public trail and to the south.

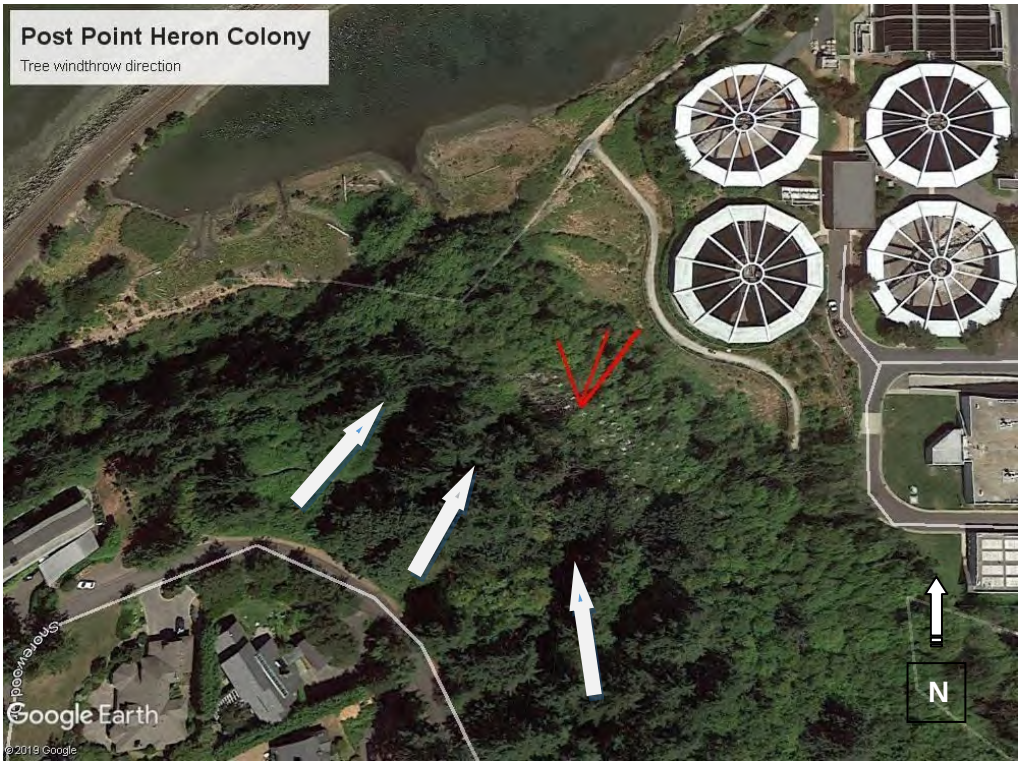


March 2019 - alder wind-throw on north side of colony – A. Eissinger



2018-2019 Storm damage to the colony and northern buffer, creating gap in the nest stand from the public trail to Shorewood Dr. - photo taken from public trail to south. Photo by T. DuBow

Figure 16. 2018-2019 Wind-throw in Heron Colony and Northern Buffer



White arrows indicate wind direction, red arrows are wind throw direction

5.5.8. Other Disturbances

While most disturbances are identifiable, certain activities or occurrences are difficult to explain. Numerous golf balls have been found in the heron colony periodically. The first incident was in 2006, but continued in subsequent years. These were likely hit into the colony from a location outside of the colony, either a nearby residence upslope (south) of the colony, or somewhere associated with the PPRRP grounds, which is unlikely. Golf balls at high velocity can cause serious injury or possible death to both adult and young heron. The source, timing and responsible party for the repeated and potentially harmful acts is not known.

Heron colonies are less tolerant to disturbance early in the season mid-February to mid-April (Azerrad 2012). In early 2016 the Post Point heron colony was unsettled and the herons acted nervous, abruptly flushing or leaving the colony without obvious reason. At one point they evacuated the colony, but returned by the following monitoring visit. The cause of this nervousness was not determined, however certain potential causes of disturbance were reported during this time including: a low flying helicopter over the colony during this same period, and a maintenance crew weed-wacking near the colony. The previously mentioned unauthorized pedestrian trail linking the PPRRP public trail with Shorewood Dr. may also have contributed since users of this trail may have caused disturbance by entering the colony edge. It should be noted that the colony in 2016 had the lowest productivity ever recorded, so the early season disturbance may have been more pervasive during the season than observed.

Photographs taken for real estate advertising of a lot proposed for development on Shorewood Dr. occurred in 2019. Aerial photos were taken over the colony, and others appeared to have been taken from within the colony's southern no-entry zone, per 2003 Management Plan, during the heron's incubation period in March or April 2019. The aerial photographs would have required a low-flying aircraft, helicopter or drone which would have potentially caused disturbance to the nesting herons. Neither city personnel nor the monitoring biologist was consulted prior to the taking of these photos.

Despite the many disturbances both temporary and sustained over the years, the Post Point Heron Colony has demonstrated tolerance and resilience. The attributes of the habitat and nest stand have also likely contributed to the colony's stability. Few colonies abandon mid-season two years in a row and return. However, in the case of Post Point, the herons returned and the colony has grown.

5.6. Disturbance Reduction

As an urban colony the Post Point heronry is subject to a wide array of human activity and noise. In spite of the close proximity to an off-leash dog park, a municipal waste water treatment facility, railroad corridor and residential homes, the herons selected the site to nest and have been successful 18 out of 20 years. Herons in urban environments exhibit a greater tolerance for human activity (Vennesland 2000).

Although urban colonies have a higher tolerance level, new activities should not add to the intensity of disturbance a colony has historically tolerated and adapted to (Azerrad 2012). It may be argued that the expansion of the PPRRP was a significant disturbance, which is evidence that the heron colony could tolerate just about anything. However, the PPRRP project employed timing restrictions, setbacks and did not infringe on the nest stand or protective habitat surrounding the colony or roost sites which are the heron's safe zone. Therefore to minimize disturbance is important, even in an urban environment.

Since 2014, there has been minimal detectable disturbance at the heron colony. The greatest disturbance currently are the trains passing blaring horns and screeching on the tracks, and people on the beach with their dogs. However, preventable disturbance should be avoided.

At Post Point possible human related disturbances include: human intrusion into the colony or feeding areas, loose dogs, loud activities or noises near the colony, clearing brush, tree or brush cutting, construction, low flying aircraft or drones, just to name a few.

Effective tools to minimize disturbance to a heron nesting area include: buffers or setbacks (including aerial), restricting access, retaining or planting dense native vegetation around the site (vegetative buffer), creating a barrier, timing restrictions, reduced noise and artificial lighting, and restriction of certain activities.

The following general guidelines are used to minimize disturbance to heron colonies.

Limit Access

Limiting access into a colony or near a colony during the nesting season requires a delineation of sensitive areas, a well defined plan and active management. Access into a forested colony nesting area at any time by unauthorized personnel, should be strictly prohibited due to the high risk of disturbance. Exceptions for authorized individuals, personnel or biologists are recommended. A system for permission may be developed as well as exemptions and timing, such as areas inside public trails or other use areas.

The restriction of human access into a heronry during nesting is essential, as repeated disturbance to the herons during nesting could cause the evacuation of the colony. Access into the colony area during the breeding season is particularly sensitive and this restriction should be enforced. Dogs should also be restricted from heron colonies and associated habitat.

Currently at Post Point there is a fence along the public trail to the north of the colony and no public access beyond that fence is allowed, that includes to the west into the lagoon area. In the early 2000's dogs were allowed to run freely along the trail and swim in the lagoon. As a result, the lagoon edge was denuded and herons did not use that area. But with the addition of a fence along the trail, and designated off and on-leash areas, the dogs are excluded from the lagoon and the herons returned to utilize that habitat.

In the past fences at Post Point were used sparingly due to concerns for restricting wildlife movement. However, as the heron colony grows and public use increases, fences may be needed to maintain separation between people, their pets and the heron colony. Recommendations from the 2003 Plan to plant thorny shrubs in the buffer of the colony have been implemented.

Buffers

Buffers are used to create distance between the sensitive nesting area and human activity. Vegetated buffers are particularly advantageous as they serve as visual screening as well as providing distance. If buffers are thick vegetation they may also provide noise abatement. By maximizing natural vegetation, including trees and understory, around a heron colony, the herons will have a greater sense of isolation and safety.

Aerial buffers are also suggested for heron colonies that may be subjected to low flying aircraft.

Barriers

Barriers have been identified as most effective; particularly open water bodies (Skagen and Melcher 1996). Other types of barriers include dense vegetation, fences and other man-made structures. Not all colony sites require or can accommodate barriers. Barrier placement planning requires an understanding of other species that are resident or use the area seasonally and that may be adversely affected by a barrier.

Timing Restrictions

Timing restrictions are an effective tool to control disturbances related to specific projects or maintenance activities. Working outside of the breeding season allows for greater flexibility in the level of activity related disturbance and/or noise.

Determination of a heron colony's nesting cycle and annual chronology is needed. Based on the monitoring of a colony, the regular breeding season and variations may be established, and then used to set timing restrictions in and around the heronry to limit disturbance and avoid impacts.

Disturbance reduction recommendations specific to the Post Point Heron Colony are provided in the following section.

6. MANAGEMENT AND RECOMMENDATIONS

The 2019 Post Point Heron Colony Management Recommendations are an update of the 2003 Post Point Heron Colony Management Plan. While the 2003 Management Plan provides an excellent foundation, this update also utilizes new guidelines from Washington Department of Fish and Wildlife (2012), best available science, advice from regional heron experts, and monitoring results from the Post Point Heron Colony.

The WDFW Priority Habitats and Species Management Recommendations for Great Blue Heron (Azerrad, 2012) serves as a guidance document for this 2019 plan update. The updated 2012 PHS Management Recommendations offers urban heron colony management considerations and direction. The guidelines provided by WDFW are generic for heron colonies throughout Washington State. Information about Great Blue Heron range, nesting, habitats and need for protection are also discussed.

In addition to the WDFW guidelines, this section will also include recommendations specific to the Post Point Heron Colony which are based on the author's over 25 years of professional field work with Great Blue Herons in the region and Nahkeeta Northwest's 15 years of on-site monitoring and empirical data collection from the Post Point heron colony. The detailed results of the Post Point monitoring are summarized in the "Background Information" section of this document and are also detailed in the Post Point Heron Colony Annual Reports 2005-2019, available on the City of Bellingham Public Works Department website.

The management recommendations herein are provided to the City of Bellingham for their information and discretionary use. The recommendations provided do not take into consideration property ownership; therefore, implementation and enforcement may be limited by property ownership and regulatory authority.

It is recommended that the Post Point Management Recommendations be reviewed and updated at a minimum every 10 years.

6.1. Management Framework

Great Blue Herons in the Salish Sea are a vulnerable species due to their large seasonal reproductive aggregations, exposure to disturbance, predation, and reliance on highly sought after coastal habitat. Management and conservation of Great Blue Heron colonies and supporting habitats, particularly foraging areas, is required in order to protect the regional population from decline. A combination of management tools are used to accomplish the protection of heron colonies including: regulatory, voluntary conservation, acquisition, and in some cases public-private partnerships. Public, governmental, tribal, trans-boundary and political support are also needed to protect vital habitats that maintain the regional heron population.

The primary goal of the Post Point Heron Management Recommendations is to define the conservation needs and management requirements necessary to sustain and perpetuate the Great Blue Heron's successful reproduction and use of the Post Point Heron Colony and associated habitat. This document provides a summary of what we have learned from monitoring the Post Point colony (background information), and sets forth a framework for management and protective actions for the. Post Point Heron Colony.

The recommended management objectives include the following.

- Identify and protect the Post Point Heron Colony nesting site and vital associated habitats year-round.
- Minimize disturbance to herons, the heron colony, and associated habitats.
- Maintain the function and ecological value of heron habitats in the vicinity of Post Point and habitat areas known to be important to the colony.
- Enhance the function and ecological value of heron habitat where possible.
- Provide public education to support these management objectives.

The 2012 WDFW PHS Great Blue Heron Management Recommendations provide steps to assess a heron colony site, identify associated habitats, and then assign protective measures to key habitat areas. These steps require an understanding of heron life history and habitat requirements, thorough on-site assessment and data collection or an understanding of existing data, mapping, review of local landuse regulations and land ownership, and working with owners and authorities to devise a plan and assign management or conservation measures.

The first step in the process is defining the Heron Management Area (HMA). This is done through site assessment and data collection. The primary goal of the HMA assessment is to document a colony's spatial and functional characteristics, which include the colony location, nest and nest tree numbers, configuration, associated habitats, nesting chronology, sensitivity, possible limitations, etc. This information is compiled and mapped, then used as a tool to inform management of the colony over time. As stated in the WDFW recommendations regarding the HMA "*you should protect all these areas as disturbance to any part of an HMA can harm the colony*." Habitat protection is therefore an essential component in management of a heron colony, to ensure the sustainability of a colony and the perpetuation of the species within a given geographic area.

The HMA assessment information for the Post Point Heron Colony has been collected, mapped, and provided in detail in Sections 3, 4, and 5 of this document. The ongoing monitoring of the colony also updates this information on an annual basis.

The second step involves assigning protective measures to the HMA to ensure that the function of the colony and associated habitats are retained and that the colony is sustainable over time. The recommended protective measures for the Post Point Heron Colony are organized at three scales which include:

- habitat specific protections,
- buffers or setbacks centered on the colony, but overlay other habitats,
- reserve area – encompassing the colony and all associated habitats.

A third step includes the identification and protection of alternate nesting areas within 0.6 mi of colony or 1.9 mi of foraging areas. This is to conserve potential nest stands for future heron use.

In addition to the assessment and defining protection measures, are recommended supporting management actions. These include: restoration and enhancement, site management and security, colony monitoring, and public education to build awareness and compliance with protection measures.

6.2. Habitat Protection Recommendations

The Post Point Heron habitat areas have been previously described in the Background Information section of this document. The Post Point Heron Colony habitat areas are illustrated in figure 5.

The habitats include:

- Colony or nesting area: the colony nucleus consists of trees with nests and the area is defined by the perimeter of the nest trees,
- Nest stand: contiguous forested area surrounding the colony,
- Roosting and loafing areas: trees, field, shoreline and nearshore wetlands - these also serve as fledging sites for young,
- Staging habitat: pre-nesting congregation areas,
- Foraging habitat: areas of feeding concentrations during the nesting season.

6.2.1. Colony Nucleus

The nesting area and colony nucleus are described in sections 3.3.1, 3.4.1, and 5, and illustrated in figures 3 and 5.

Recommended Protection Measures

The colony nucleus requires full year-round protection. Protection of all vegetation including forest, nest trees and understory - must be maintained in a natural unaltered state.

Only authorized access should be allowed, and no access during the nesting season January 15-September 1 except authorized personnel and the heron monitoring biologist.

The most sensitive period for the colony is the early season prior to incubation or January-March.

Protection of the airspace above the colony should be pursued by creating a no-fly-zone for drones and requesting the US Coast Guard and other helicopter operators to maintain at least 1000 feet elevation* in order to avoid disturbance and downwash if possible. (* FAA minimum height for fixed winged aircraft over urban areas is 500 ft.)

Vegetation restoration and enhancement should be allowed only between September 2 and January 14, and should be further defined by the recommended vegetation management plan. All plants need to be pathogen and pest free.

It is recommended that the air quality be evaluated at the site to determine whether any airborne constituents from the PPRRP could have a possible health impact on the herons or their young, and mitigate any potential impacts if possible. A passive air sampler could determine compounds being emitted.

6.2.2. Nest-Stand – Associated Forest

The nest stand and forest habitat area is described in section 3.3.1 and 3.4.1, and illustrated in figures 3 and 5.

Recommended Protection Measures

The Post Point nest-stand area requires year-round protection as a whole.

The WDFW guidelines recommend a minimum 197 ft. year-round buffer to protect the colony nucleus and surrounding habitat, however additional habitat protection may be necessary. This is further described in section 6.3 Buffer Recommendations.

Avoid areas when and where herons are present.

Only authorized access should be allowed on public property, and no access during the nesting season January 15-September 1 except authorized personnel and the heron monitoring biologist..

Aerial protection should also be enabled by creating a no-fly-zone for drones and requesting the US Coast Guard and other helicopter operators maintain at least 1,000 feet at the very minimum altitude in order to avoid disturbance and downwash.

Vegetation restoration and enhancement is allowed only between September 2 and January 14, and should be part of the recommended vegetation management plan. All plants also need to be pathogen and pest free.

Due to the loss of trees in the colony and nest-stand from high winds in 2018-2019, there is a need to retain all trees within the forest particularly to the south and west in order to maintain a windbreak from prevailing winds and higher velocity wind storms. Restoration of trees to fill gaps caused by storms on the north and south sides of the nest stand is recommended.

6.2.3. Roosting and Loafing Areas

The Post Point roosting and loafing areas are scattered within the nest-stand and lagoon shoreline, as described in sections 3.4, 3.4.1, 3.4.2, 3.4.3 and illustrated in figure 5.

Protection of roosting and loafing areas is needed to maintain the vital habitat components of this site. Protection for roosting areas, includes maintaining not just the large fir trees, but the forest stand as a whole which provides the shelter, sun or shade, wind break and screening needed for the herons to rest, preen and not be disturbed.

Recommended Protection Measures:

No tree cutting, pruning, or thinning is recommended within the nest stand or documented roost sites.

Avoid areas when and where herons are present.

The open, ground loafing areas around the Post Point Lagoon should be off limits year-round except by authorized personnel.

Large patches of open grass or low-growing, non-woody, salt marsh plants should be maintained with open access to allow for herons to fly in and out and to reach the water where herons may forage.

Vegetative screening from the public trail and railroad is recommended where possible.

6.2.4. Staging or pre-nesting areas

The Post Point staging is not a single location, but several locations in close proximity to the colony. These areas include the PPRRP western clarifiers, the roosting area associated with the colony and to the west and loafing areas along the lagoon shoreline. Staging is mentioned in section 3.4, and described in section 5.2. Staging areas are illustrated in figure 5.

The timing of staging varies annually at Post Point, between January 15-March 15 (figure 10).

Recommended Protection Measures

Avoid areas when and where herons are present.

Protection of staging areas will be accomplished by maintaining both roost and loafing areas – that include large conifer trees to the south and west of the colony. No tree removal or pruning of these areas due to their year-round use. Maintaining screening of these areas is also recommended.

Review of the clarifiers and associated structures is needed to ensure that these structures and other roof top areas are bird-friendly. Use of bird deterrent wires, spikes or other physical repellents on the PPRRP structures should be removed and/or prohibited as they cause injury to herons. Non-lethal or non-injurious deterrents (except lights and sounds) are recommended. Lights and sounds can be disruptive to the colony.

6.2.5. Foraging Areas

Areas with concentrations of herons feeding during the nesting season are particularly sensitive to disturbance. Locally these areas are usually along marine shorelines where large numbers of herons occur during the nesting season.

Disturbances to feeding herons and activities limiting the use of foraging areas by herons include:

- human activity on the shoreline or nearshore, including the use of kite boards, kayaks and other shallow draft vessels,
- off leash dogs on the shoreline
- high wave action or boat wakes
- loud train horns
- low flying aircraft or drones
- kites
- fireworks (illegal in the City of Bellingham but not outside the city limits)

Foraging areas are described in section 3.4, 3.4.2 and 3.4.3, and foraging disturbance 5.5.2. Foraging areas are illustrated in figures 5 and 7.

Recommended Protection Measures

Protection of the Post Point heron's primary foraging areas is recommended. These areas should also be periodically monitored for use, disturbance issues and habitat health.

A heron foraging survey update is needed in addition to an updated evaluation of eelgrass presence and status in enhancement areas

The WDFW recommends the reduction of disturbance for foraging areas during seasonal use periods between March-September, and to minimize certain activities where herons feed. Specific recommendations relevant to the Post Point Heron Colony foraging areas include:

- Restrict removal (or disturbance) of aquatic vegetation, especially native eelgrass
- limit use of all watercraft within 180 meters (590 ft) of shallow waters where herons forage
- Keep dogs on leash
- Disallow logging mature forest (or roost trees) close to nearshore foraging habitat
- No removal of perch trees adjacent to foraging areas
- No draining, filling, or dredging wetlands or marshes
- No building close to riparian shorelines

In addition to WDFW recommendations, the following foraging area guidelines are also suggested for consideration:

- Avoid herons when and where they are present
- Pedestrians should maintain a distance of at least 300 feet from foraging herons (Rogers and Smith 1997) (or place seasonal use restrictions on Post Point shoreline due to limited beach margin of only 300 feet at lowest tide)
- Prohibit the use of drones – no drone zone
- Prohibit the flying of kites
- Prohibit the use of kite boards

  Note: The Post Point beach is 300' wide at widest point from riprap to lowest minus tide edge (Google Earth 7/10/2014)

Heron foraging area protection pose particular challenges as shoreline areas available for public access and recreational use are both limited in Bellingham and also in high demand. In addition, foraging areas extend outside City-owned property. Discussion with owners and user groups to help avoid conflicts with herons is recommended.

The Marine Park shoreline is the site of the most known conflict between herons and people and dogs. This is a high use area with seasonal events such as Ski to Sea. Generally, the restored gravel beach area is little used by herons. However, the lower tide zone of cobble, mud, sand and eelgrass extending south to Post Point is used by herons and is a primary feeding area for herons during the nesting season, and is the closest feeding grounds to the colony. Due to the importance of this intertidal area for herons, this needs greater management priority and protective action by the City of Bellingham and the Port of Bellingham. Seasonal use restrictions are needed. Informative signage on the beach and/or a temporary fence during Ski to Sea if the tide is expected to be low (below 2 ft.), are recommended. Monitoring of management actions is also needed to determine effectiveness. Further discussions and actions are needed to address conflicts between people, dogs and herons on this beach.

Foraging sites on the west side of Bellingham Bay require more study and discussions with the Lummi Tribe, and Washington Department of Natural Resources to better understand the management of those tideland areas. Monitoring and mapping of the heron's use of Portage and Brant Island shorelines specifically is recommended and also greater Bellingham Bay and Chuckanut Bay to update existing data is needed.

6.2.6. Alternate Nesting Locations

The 2012 WDFW Management Recommendations – HMA assessment includes the identification and preservation of alternate nest stands. The landscape specifications suggested by WDFW include:

- 10 acre minimum
- Dominant trees of 56 ft. or more in height
- Stand with similar structure and tree species composition as current nest stand
- Possible location of satellite nest

- Possible location of former colony
- Within 0.62 miles of current colony and 1.9 miles of foraging habitat

The alternate nesting locations identified in 2003 included the Chuckanut Community Forest, Hoag's Pond, the northern toe of Chuckanut Mountain Arroyo Park and Clark's Point. After re-examining these sites for habitat suitability, isolation, protection from prevailing winds and proximity to foraging areas, Clark's Pt would be dropped due to exposure and negative nest stand characteristics and Arroyo Park would also be dropped for the latter reason. Chuckanut Bay, inside the railroad trestle at Chuckanut Bay Open Space may be a suitable nesting site but would require further evaluation. The Chuckanut Community Forest contains about 20 acres of suitable nesting substrate, however not all of this acreage is contiguous and most is associated with wetland complexes and also a high density of public trails (Eissinger 2015). To confidently identify suitable alternate nesting areas for Great Blue Heron, a more thorough examination of available habitats is recommended.

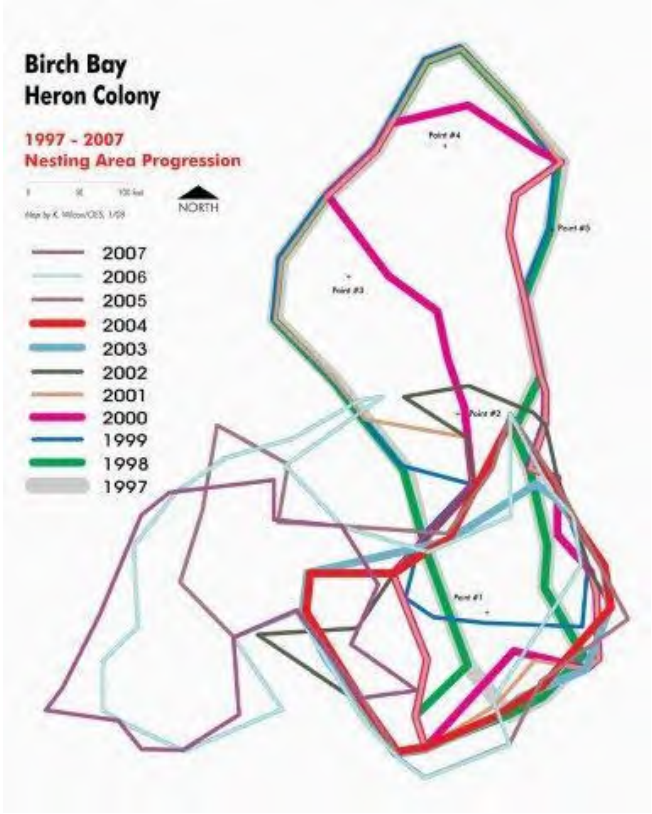
6.3. Buffer Recommendations

Buffers or set-back distances are used as a management tool to create separation between sensitive wildlife areas and human activity. Buffers reduce disturbances to sites where herons (or other species) assemble to nest or feed and aid in the reproductive success of colonies (Vos et al., 1985)(Rodgers and Smith 1995) (Vennesland 2000) (Vennesland, Butler 2011). Vegetated buffers retain the natural forest vegetation around heron colonies, which provide visual screening, physical barrier, protection from wind and storms, maintains the microclimate and if dense enough reduces noise and discourages human entry.

A heron colony buffer is applied as a radius measured from the outer perimeter of a heron colony's nest trees and is set on a horizontal plane (Azerrad 2012, pers. com.). Uniform buffer distances around a colony provide for equal protection assuming there is uniform habitat and conditions distributed on all sides. The buffer line should be applied as a soft boundary, as it will change annually with nest tree use changes or colony expansion or contraction.

Most colonies shift their nests within the nest stand annually, and some may move over 100 ft. in a single season. This movement has been documented through multi-year colony mapping at March Pt. Samish Is., Birch Bay, and Pt. Roberts. An example of colony movement is illustrated in Figure 17, which represents the Birch Bay heron colony perimeter between 1997-2007.

Figure 17. Heron Colony Nesting Area Migration



The vertical height of the nests in trees adds additional vertical buffer from the ground, which vary in height depending on the site and tree species. At Post Point the nest tree height is about 80 ft. It has been observed, that nesting herons situated in taller trees and providing higher nest height tend to solicit less response to human activity on the ground than lower nests (Eissinger pers. obs.). Based on these observations, if a colony is located on a slope, human activity upslope of the colony, or at the same level as the nests, eliminates the buffering effect of the nest height, and is thus likely to cause greater stress or response by the herons. This consideration applies to the Post Point colony (Figure 6).

The nesting heron's line-of-sight is also a factor and disturbance could be amplified if human activity is occurring at the same level or up slope from active nests. Vegetation is also a consideration for screening and varies by site and season. There is no established formula for adjusting buffer distances for slopes; however topography should be taken into consideration when setting buffers, and adjusted to protect the colony from any proposed action may infringe on the colony or associated habitat up slope from the colony.

6.3.1. Post Point 2003 Buffer Recommendations

The 2003 Post Point Heron Management Plan provided a detailed overview of buffers and their application. The buffers applied to the Post Point heron colony in 2003 included the following.

- 100 ft (150 ft*) permanent core area, no-entry buffer – year-round, retain habitat, restrict access with fencing or plantings to form natural barrier.
- 250 ft (300 ft*) permanent non-disturbance buffer, safety zone for herons – seasonal restrictions March 1-September 1, restricted use in designated areas only include: passive recreation and motorized maintenance. Retain habitat screening. Limit further human development.
- 500 ft (550 ft*) restricted application of pesticide (herbicides and insecticides)
- 820 ft (870 ft*) WDFW timing restriction buffer (February 15- September 1) for noise and other activities causing significant disturbance (high magnitude stimuli).

*includes the 50 ft setback from the base of perimeter nest trees.

In addition to the buffers at Post Point, there was a recommendation to designate a permanent heron/wildlife Reserve Area that would include the heron colony and its associated habitat. The proposed reserve area included the existing natural area surrounding the colony, both public and privately owned land. Restoration and enhancement of this habitat area was also recommended. Throughout the 2013 management plan, the protection of the private land adjacent to the colony was also recommended.

6.3.2. WDFW 2012 Buffer Recommendations

In 2012 the WDFW updated its PHS Great Blue Heron Management Recommendations. The update included a more comprehensive account of colony assessment and management options including urban colonies. Buffer recommendations were also updated and tailored to setting and conditions.

As stated in the WDFW PHS 2012 heron recommendations, a buffer's primary function is to:

- provide protection from potentially intrusive activities,
- provide a physical and visual barrier,
- protect colony from tree blow-down (wind-throw),
- provide space for herons to move around the colony area,
- provide space for a colony to move and expand.*

*A colony with *"an adequate buffer, with room to move or expand, increases its longevity and productivity"* (Azerrad 2012). This is an important consideration when adopting buffers or other protections around a colony.

The 2012 WDFW buffer recommendations for herons are focused on nesting areas or colony sites. These include year-round buffers and seasonal buffers. The year-round buffers are prescribed to colonies in one of three settings: urban, suburban/rural and undeveloped. The seasonal buffers are for disturbances of higher magnitude particularly noise.

WDFW Year-round Buffers (core zone):

- 197 ft (60 m)* for urban colonies, urban areas = ≥ 50% built within ¼ mile of colony,
- 656 ft (200 m) for suburban/rural colonies, suburban/rural areas = 2-50% built within ¼ mile of colony.
- 984 ft (300 m) for undeveloped areas = 0-2% built within ¼ mile of colony.

*urban colonies with herons that exhibit behavior indicating a low tolerance to people should assign larger buffers to 984 ft.

WDFW Seasonal Buffers (quiet area):

- 656 ft (200 m) February to September for unusually loud activities with noise reaching the colony exceeding 92 dB.
- 1,320 ft (400 m) February to September for extremely loud activities like blasting.

The buffer distances are measured from the perimeter of the colony nest trees and are usually made on a horizontal plain which does not take into account topography. Buffers need to be designated to protect the colony by providing both a physical and visual barrier, wind screening to protect nest trees from wind-throw, and provide enough area for the herons to move around without disturbance (Azerrad 2012, Vennesland 2017). Heavily vegetated buffers also may reduce noise and inhibit entry to the nesting areas.

The WDFW recommendations for urban colonies are based primarily on the British Columbia Ministry of the Environment for Land Development (2006).

6.3.3. Other Buffer Recommendations

Buffer recommendations vary and are not applicable in all cases, but depend on the site conditions, the heron's sensitivities, location, and in some cases the type of disturbance. Ross Vennesland a professional Wildlife Biologist and author of many scientific papers on Great Blue Heron has noted *"Overall, studies on Great Blue Herons have quoted various buffer widths, with most ranging from 250 m to 300 m. One study recommended buffers of up to 1,000 m.* (see the Great Blue Heron species account in North American Birds by Vennesland and Butler 2011). *It should be noted that most studies do not provide strong evidence-based justification for recommended buffer widths"* (Vennesland 2017).

A more recent and thorough literature review of Great Blue Heron colony buffer recommendations was completed in 2017 by Ross Vennesland and is yet unpublished. The conclusion from his review of existing literature and backed by his own data (Vennesland 2000) was that for colonies within the relatively developed southern mainland coast of British Columbia (Salish Sea), heron colonies require a buffer of 108 meters (350 ft.) for urban settings, and 168 m (551 ft.) for rural settings, to protect from low magnitude disturbance. The geographic area he is referring to is immediately north of the US/Canada border and has similar conditions as the Bellingham area.

6.4. Post Point Heron Colony 2019 Buffer Recommendations

The following buffer recommendations for the Post Point Heron Colony are updated from the 2003 management plan, and are based on WDFW recommendations, as well as, elements of other studies described earlier this document, and site specific considerations which include: habitat condition, screening, wind protection, micro-climate, colony expansion/movement, new nest tree recruitment, topography and human activity. Empirical data and observations from 15 years of colony monitoring also informed the recommendations and their suggested application.

The recommended buffers for Post Point 2019 are illustrated in Figure 18.

The buffer distances are measured from the perimeter of the colony nest trees unless otherwise noted.

1) **197 ft. year-round colony core zone buffer (WDFW minimum buffer for urban colony)**
This area includes the colony nucleus and buffer which form the colony core zone totaling 3 acres. This buffer is measured from the nest tree perimeter out 197 ft.

Restrictions (unless listed as allowed actions below):

- no disturbance to herons, heron colony or associated habitat or vegetation
- no disturbance to heron or Bald Eagle nests
- no vegetation alteration, removal or tree cutting or pruning within the forested area unless defined in the recommended vegetation management plan
- no access into colony nucleus except for authorized personnel and heron monitoring biologist
- no access into associated buffer area except for authorized personnel and heron monitoring biologist
- no public access on public property except on designated public trail – pedestrian use only
- no event activities, marathons, races or other potentially disturbing public trail use
- no clearing, grading or development
- no exterior lighting directed at colony area, or high intensity lighting (need to evaluate lighting at PPRRP)
- no drones

Allowed actions in buffer area:

- routine activities inside PPRRP grounds at ambient noise and light levels – minimize activities between January 15-September 1
- retain all native vegetation unaltered within buffer and on edges
- a vegetation management plan is recommended to address maintenance activities and timing within buffers and heron habitat areas
- Protective fence construction between September 2 - January 14

Considerations:

- This is not a fixed buffer or boundary – it changes each year with the heron nesting location and may flex by 50-100 ft., requires annual update.
- This buffer is not large enough to sustain or protect the colony over time, so additional protected area is needed..
- Buffer includes public and private lands.
- Exemptions or provisions for certain actions on private and public areas within the buffer need to be determined by the City of Bellingham.

2) 300 ft. year-round habitat/vegetation protection and seasonal no-disturbance buffer

This buffer is consistent with the 2003 Management Plan, and recommendations from Vennesland 2017. This buffer includes contiguous forest vegetation outside the core zone and is valuable habitat supporting nesting, and provides screening, wind break, and barrier functions. The buffer is measured from the nest tree perimeter creating a buffer of 103 feet between the core zone and the outer perimeter.

Restrictions:

- no disturbance to herons or Bald Eagles anytime,
- no disturbance to heron or Bald Eagle nests anytime,
- no disturbance to, or alteration of, vegetation or associated habitat within nest stand or contiguous forest area,
- no-access restricted area January 15-September 1 (exemptions or provisions for certain actions on private and public areas within the buffer need to be determined by the City of Bellingham)
- no exterior lighting directed at the colony, or no strobe, spot or high intensity lighting,
- no application of pesticides (herbicides and insecticides) without permit,
- no large events or related activities, marathons, races, or other potentially disturbing activities in public spaces or trails,
- no drone use.

Allowed actions in buffer area:

- allow vegetation enhancement or restoration on public property where needed to maximize screening and windbreak, or suitable heron habitat - per vegetation management plan, timing restrictions apply, no work January 15-September 1,
- retain all existing native vegetation unaltered in undeveloped spaces,
- retain all existing trees for screening and wind break,
- a vegetation management plan is recommended to address maintenance activities and timing within buffers and heron habitat areas.

Considerations:

- Consistent with 2003 non-disturbance buffer
- Similar to buffer recommendation for urban colonies by Vennesland 2017

- Exemptions or provisions for developed private and public areas within the buffer need to be determined by the City of Bellingham.

3) **650 ft. (850 ft total from colony perimeter) seasonal quiet buffer – extreme disturbance reduction zone**

This buffer includes a large area around the colony for seasonal disturbance reduction.

Restrictions:

- seasonal restrictions apply January 15 to September 1
- restrict activities causing loud noises > 92dB at the colony or other activities of high magnitude stimuli causing significant disturbance such as flushing of herons or temporary nest abandonment, or negatively affecting reproductive success
- no strobe, spot or high intensity lighting
- no gunning practice (previously experienced off shore >850 ft by US Coast Guard)

Allowed actions in buffer area:

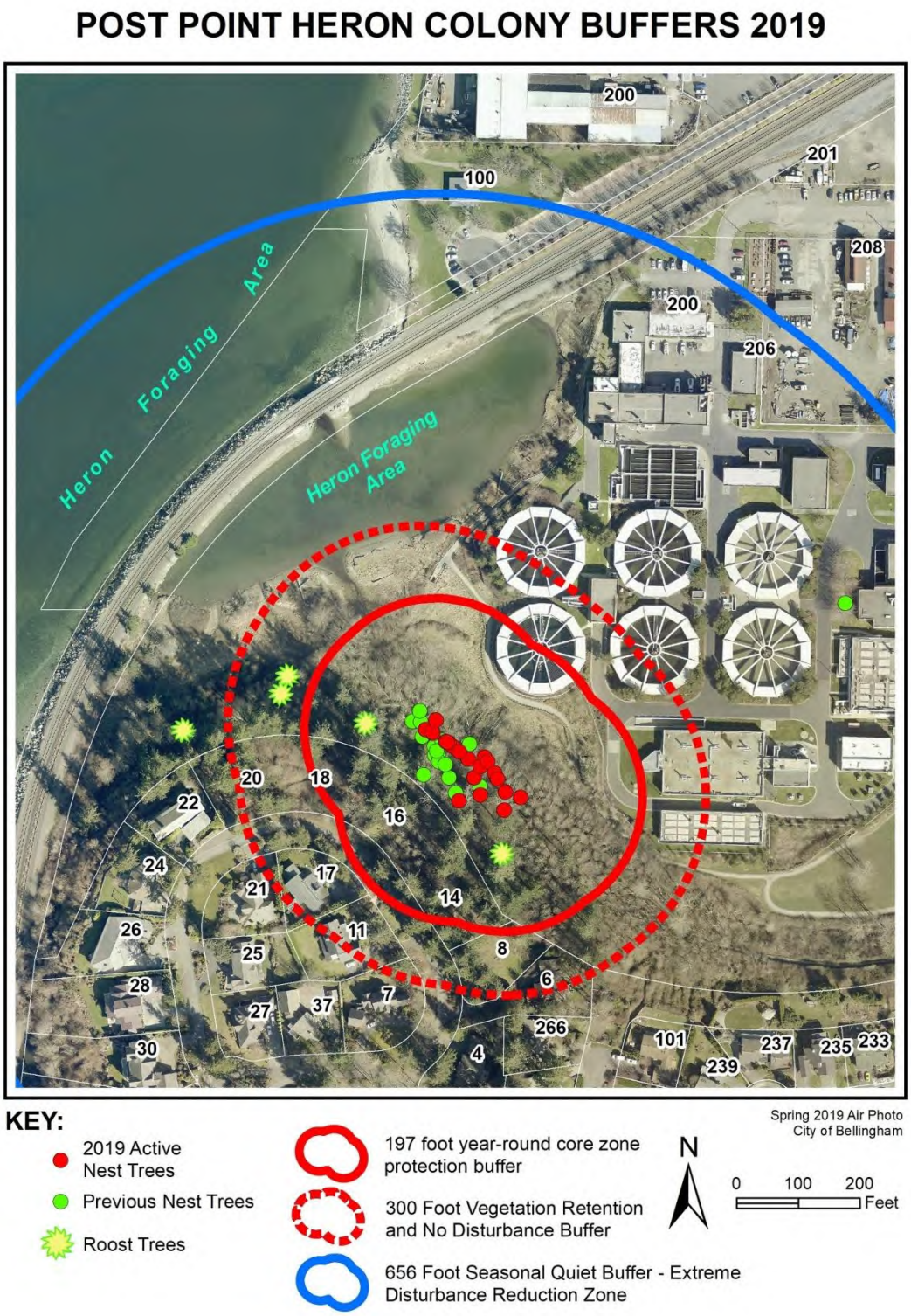
- all normal activities outside the 300 ft. no-disturbance buffer that are within ambient sound and activity levels are allowed.

Considerations:

- WDFW recommended seasonal buffer for excessively noisy land use activity.
- Buffer includes public and private lands.
- The proposed railroad quiet zone would benefit the heron's habitat use at Post Point, support for the quiet zone is recommended. It is recognized that quiet zones require BNSF approval, BNSF construction, Port of Bellingham participation, and all crossings in a zone meeting quiet zone standards
- Exemptions or provisions for certain private and public areas within the buffer need to be determined by the City of Bellingham.

The WDFW 2012 heron buffer recommendations also include a 1,320 ft. buffer for any extremely loud activities or high magnitude disturbance such as blasting which are unlikely in or near an urban area. Regarding other potential high magnitude disturbances, large commercial or municipal fireworks displays likely qualify. Although guidance specifically for fireworks near heron colonies is not readily available, a precautionary approach to this issue is advisable. The annual Fourth of July fireworks displays launched on Bellingham Bay need review for any disturbance, since these occur at the fledging stage in the heron colony and have not been considered in prior monitoring. The distance from the colony and duration of the display would be important to document in addition to any response by the herons. Monitoring the heron colony prior to and following the event to document any response or observable change would be informative.

Figure 18. Post Point Heron Colony Recommended Buffers



6.4.1. Foraging Area Buffers

Buffers and guidelines for the foraging areas are discussed earlier in 6.2.5 Foraging Area Protection Measures. Please refer to that section for buffer and protection recommendations.

6.4.2. Flyway and Aerial Buffer

Air space over a heron colony and associated flyways are important features that have received little attention or protection. Established colonies, such as Post Point, have specific flight paths that during the breeding season may experience high use or numerous heron flights per hour. In addition, overhead or aerial disturbances by aircraft – manned and unmanned, could cause stress, and require the herons to divert their flights creating an energy deficit. Energy deficits related to long fight distances experienced by adult herons affect their reproductive success (Knight, Vennesland and Winchester 2016). There are also other impacts from low flying aircraft including high intensity noise, and downwash from helicopter rotors causing high velocity turbulence that can dislodge nests and their occupants.

As stated in the 2003 management plan, it is recommended to examine the flight patterns and potential aerial disturbances to determine if the Post Point colony will require a flyway or aerial buffer. Although observations are made during monitoring visits to the Post Point colony, no systematic data is collected specific to heron flights or aerial disturbance, however, flight directions were regularly noted. Reports of low flying aircraft have been reported over the heron colony, including helicopters, and the use of drones near the colony has also been reported.

A brief summary of studies related to aerial disturbance (below) were provided in the 2003 Post Point Heron Colony Management Plan, and more recent studies are also available.

> *Disturbance by aircraft include several variables including size, speed, color, proximity, noise and direction of flight of the craft (Ward et al. 1989). Helicopters cause the greatest response for several species (Ward et al. 1989). However, frequent flights of certain types of aircraft over time reduce response by certain species including herons. It is suggested that herons may habituate to fixed wing and rotary winged vessels (Bowles 1995). Very low altitude aircraft overflights of less than 100 meters have caused panic response and caused flocking waterfowl to collide with human-made structures (Blokpoel and Hatch 1976). Kelsall (1992), based on literature review, recommended that a vertical buffer of 600-650 meters be placed over heronries to prevent harassment by low-flying aircraft. The impacts of noise frequency and magnitude on wildlife are little known (Knight and Gutzwiller 1995).*

The best approach to reducing conflicts with low-flying aircraft near the Post Point Heron Colony would be to discuss this issue with WDFW and also the local flight service professionals, including the US Coast Guard who make frequent flights over Bellingham Bay. Although helicopters are allowed to fly below the 500 ft. minimum altitude set by the FAA, altitudes of no less than 1,000 ft above the colony area would be recommended.

Unmanned aerial vehicles or UAV's, commonly known as drones, are growing in popularity and availability. Many amateur and professional photographers are utilizing drones to photograph wildlife and herons are a common target. Unfortunately, drones also cause disturbance to nesting birds and because herons nest in colonies the disturbance factor is compounded. Unauthorized and unpermitted use of drones in sensitive wildlife areas, such as heron colonies and their feeding areas may be considered harassment by WDFW.

Based on FAA rules, drones are not allowed to be flown in controlled airspace including within 5 miles of an airport such as Bellingham International (BLI), and must be flown below 400 ft altitude in uncontrolled airspace. Because Post Point is just outside the controlled airspace of the airport and flying drones near a heron colony, particularly under 400 feet may be considered harassment, it is recommended that the heron reserve area (Figure 19), and discussed below, be a seasonal no-drone zone from January 15 to September 1. This would also include the shoreline from Marine Park south to Post Point.

6.5. Post Point Heron Reserve

A Heron Reserve area was recommended in 2003 and is again in this 2019 update. The Heron Reserve is the largest spatial tier in the heron management update framework and is recommended as a means for the City to consolidate the heron habitats under one designation and management focus.

The proposed Heron Reserve could serve as the primary management area to protect the heron colony and associated habitats or as a compliment to the buffer areas as described earlier. The creation of a Heron Reserve would put the focus on management of all the heron habitats in a comprehensive manner and place greater emphasis on the combined habitat areas as a unit and supporting this unit as a whole. By doing so, the heron colony would benefit from a more uniform management and stewardship approach.

The Reserve area would encompass the heron colony and associated habitats on undeveloped lands and shoreline within about 1000 ft. of the colony. The reserve would be made up of an estimated 27 acres with 9 acres of upland and 18 acres of lagoon and marine shoreline. The reserve would include: 12 acres east of the railroad causeway, and 15 acres to the west. The eastern portion would include the Post Point Lagoon (3 ac), the heron nest stand (7.4 ac) and wet meadow/shrub/lagoon shoreline (1.6+ ac). The west side would include 2,500 feet of shoreline from Marine Park to Post Point including approximately 15 acres of intertidal habitat.

The Reserve area (Figure 19) closely follows the heron habitat areas that have been described and mapped earlier (Figure 5), which include: the nesting, roosting, loafing, foraging and staging areas. The reserve area as a whole would also protect vital wind break, screening and enough forest cover for the herons to gather needed nest material, find safe locations to rest, move freely throughout the area, and provide adequate space for the nesting colony to move or expand as needed while

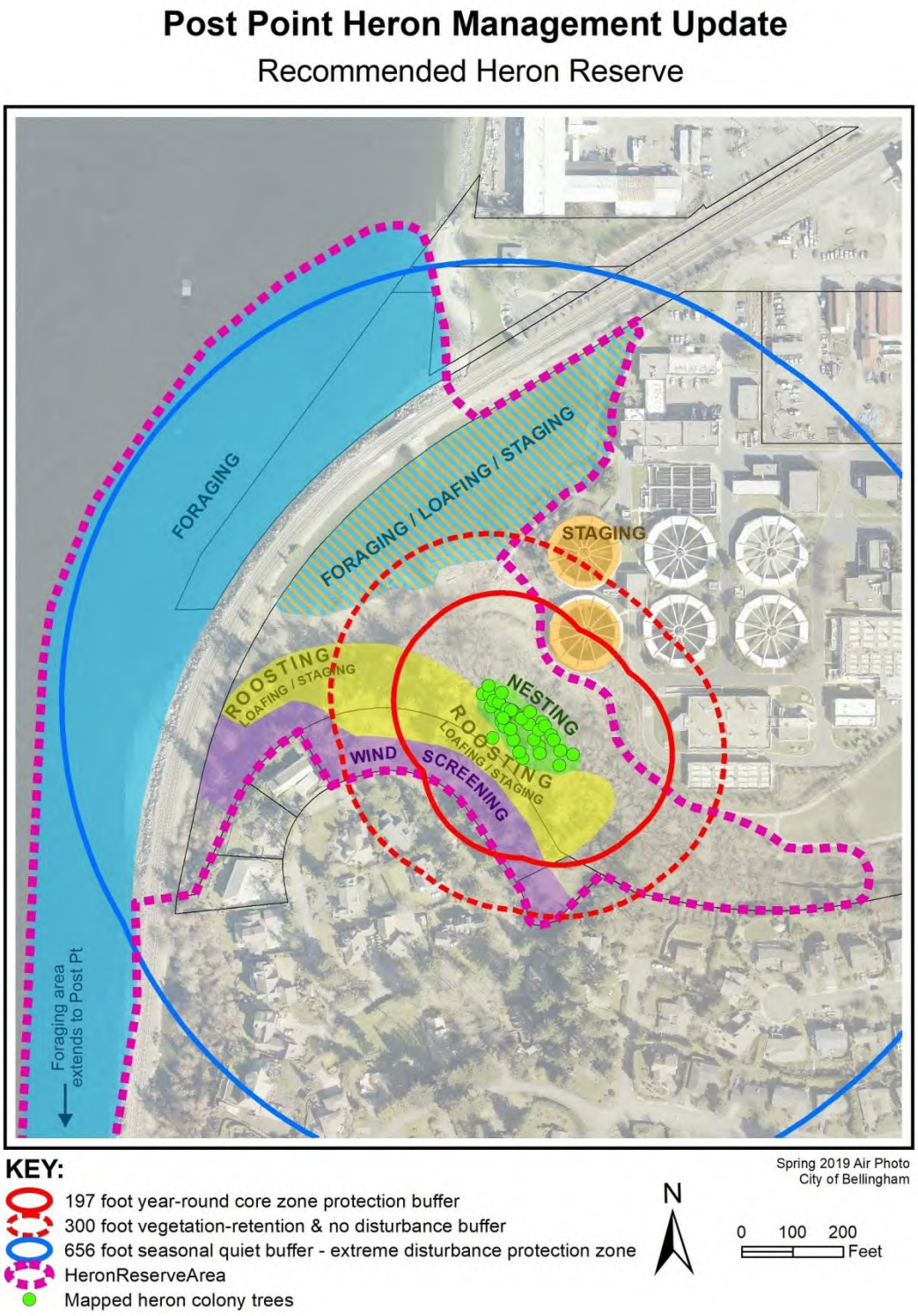
retaining functional screening. Foraging areas would also likely benefit from the Reserve designation and management focus resulting in disturbance reduction.

The Reserve area, as delineated on the map (Figure 19), includes both public and privately owned properties. Property ownerships include, City of Bellingham and private parties. The State of Washington, Department of Natural Resources controls the tidelands. The City property is part of the 30 acre PPRRP and public use area and some marine shoreline, with the railroad right-of-way bisecting the parcel on the west edge. The two private undeveloped properties identified, south and southwest of the colony (approximately 1.8 acres) are zoned for residential use and would require acquisition or some other land conservation mechanism to guarantee it be maintained in a natural state. This area as a whole is recommended for permanent protection as a publicly owned or protected wildlife/natural area.

The proposed Heron Reserve would benefit the heron colony by keeping the nest stand habitat intact and retaining the function and ecological values of the associated habitat areas over time. It would also maintain vital buffer and screening for the heron colony and allow for enhancement of the southern wind break needed to reduce further wind damage in the colony.

In addition to heron habitat, the reserve would also protect a scarce shoreline/upland natural area within the city that serves both terrestrial and marine wildlife. Although a small area, the reserve supports biodiversity from the marine waters to the upland forest. The Post Point Lagoon is considered a Priority Habitat by WDFW and is utilized by juvenile endangered Chinook Salmon. The site has also hosted over 60 bird species based on observations during monitoring visits, including nesting Bald Eagle (*Haliaeetus leucocephalus*), and Green Heron (*Butorides virescens)* and numerous other species such as: Pileated Woodpecker (*Dryocopus pileatus*), Coopers Hawk *(Accipiter cooperii)*, Band-tailed Pigeon *(Patagioenas fasciata)*, Hooded Merganser *(Lophodytes cucullatus)* and Ringed-neck Duck *(Aythya collaris)* just to name a few. This area supports a variety of both resident and migrant species.

Figure 19. Post Point Heron Reserve



6.6. Habitat Restoration and Enhancement

Restoration and/or enhancement are important to many heronry sites due to habitat loss, alteration or degradation. Restoration or enhancement can apply to nesting, buffer, outlying or foraging areas. Once the colony core and buffer areas are protected, associated habitat may be identified for restoration and/or enhancement to improve conditions for the colony in the future.

The 2003 management plan provided several suggestions for heron habitat restoration and enhancement. The 2003 recommendations for the site included buffer forest enhancement, and perimeter planting of thorny native shrubs to create habitat diversity and deter access to the colony. Enhancement of stream/wetland corridor and lagoon edge would benefit a number of species including herons. Retention of fallow meadow area is vital for heron foraging.

Over the past 16 years, several restoration and enhancement projects have been completed as mitigation for PPRRP improvements projects including:

- Trail relocation and fencing – 2002-3
- Eelgrass enhancement in the lagoon and outer shoreline – 2008
- Tree planting to the west of the colony as part of stream and lagoon restoration – 2008
- Lagoon shoreline restoration and enhancement – 2004-2019
- Wetland mitigation 2012-14
- Ongoing mitigation planting area maintenance - current

Most of these restoration and enhancement projects have provided some benefit to heron habitat; however some habitat has also been lost. In order to determine the net benefit to herons, an evaluation of landscape changes and current conditions from a heron habitat perspective would be useful and informative, and therefore recommended.

With recent significant tree blow down and tree death in and adjacent to the colony (2018-2019) a course of action is needed to restore certain areas of the colony and northern buffer. There also needs to be an evaluation of the wind break to the south of the colony due to the direction of tree fall indicating high velocity wind flowing from the south-southwest and southeast (Figure 16) . Improving the wind break for the colony would be beneficial. An assessment of damages in the nest stand, and consideration of possible restorative action is needed. A site evaluation by a professional arborist to assess tree health, wind break enhancement, and forest restoration options is recommended..

Maintaining forest health of the colony and nest stand should be a priority. No-net loss of forest around the colony could be achieved with a plan involving tree replanting and enhancement both in the stand and on the edges. A plan for restoration informed by the arborists assessment and developed with input from the heron biologist would be useful and is recommended

The wet meadow and grassy areas serves an important roll for herons and other species. The fallow grass dominated meadow (not lawn) is particularly important given that there is so little of this type of habitat remaining in the City, especially south Bellingham. Natural grassland is vital for the

heron's winter and spring foraging and habitat for the herons primary terrestrial prey the Townsend's vole *(Microtus townsendii)* and other prey species. Restoration of meadow area at Post Point would be beneficial.

A Vegetation Management Plan for Post Point is recommended to help guide restoration, enhancement, maintenance and overall vegetation management for the heron colony, buffers and associated habitat areas. The plan would incorporate information from the forest assessment, prior mitigation plans and heron habitat needs, to provide site specific recommendations and guidelines. The plan would also define seasonal timing and activity restrictions on order to minimize disturbance to herons and the colony.

6.7. Site Management and Security

Concern over the security of a heronry is an important consideration in the management and long term conservation of such a sensitive site. The Post Point heron colony is located on land owned by the City of Bellingham and is part of the larger PPRRP facility grounds which is managed by the Department of Public Works.

Since the herons established their colony at Post Point in 2000, the oversight of the heronry has been the charge of the City of Bellingham's Department of Public Works. The Department of Public Works has also been very supportive and has maintained funding for habitat enhancement work and annual biological monitoring of the colony.

The colony's biological monitoring conducted by Nahkeeta Northwest Wildlife Services, has served as seasonal oversight of the colony during each nesting season since 2005. The weekly or biweekly field visits to the site, coupled with regular reporting directly to the PPRRP supervisor has helped inform management of the heron colony and associated habitat area, and provide recommendations for improvements or needed changes. The relationship with citizens and neighbors has also helped by creating a network of individuals reporting occurrences at the colony.

Oversight of the colony area outside of the nesting season has been lacking with the exception of occasional site visits by PPRRP and other city staff. Overall the colony and nest stand would benefit from consistent stewardship year-round. This issue was also discussed in length in the 2003 Management Plan.

The security of the Post Point heron colony has been a concern over the years as people have camped, built trails and entered the non-disturbance zone without permission and in some cases have caused damage and possible disturbance to the herons. The sudden death of 4 healthy nest trees and the occurrence of golf balls in the colony although likely the result of natural or unintentional causes, could instead indicate intentional tampering or harassment. With the colony's south side boundary directly shared with private property, that portion of the site is open to access and disturbance with little or no control or visibility.

Year-round site management and security is strongly recommended. A long-term monitoring and security plan coordinated by the Public Works Department, the Bellingham Police Department, and involving PPRRP, other city staff and the heron biologist would be useful. The plan could include:

- Year-round stewardship responsibilities of the site – site visits, monitoring and reporting
- Security of the colony core and associated area - buffers and timing restrictions
- Possible fencing, signage and vegetative barriers
- Other species that needed consideration and management or protection such as Bald Eagles
- Public and neighborhood outreach and education
- Public reporting mechanism
- Enforcement
- Defining roles and responsibilities

6.8. Post Point Colony Monitoring

Biological monitoring of heron colonies is an important component of management and stewardship of the heronry and its habitat. Monitoring is essential for establishing the baseline for each individual colony beginning with the site features, defining habitats, observing the nesting cycle, establishing annual chronology, identifying behaviors, patterns, flyways, etc. As a long term tool, monitoring is used to track the colony over time and to ensure the colony is secure and functional. As a scientific tool, monitoring tracks behavior, measures yearly nesting numbers, productivity and spatial movement within the nest stand. Regular monitoring of a colony during the breeding season is essential for detecting disturbances by documenting responses to human activities, predation, and record particular behaviors that could indicate stress.

Monitoring of a heron colony is conducted on an annual basis and by a qualified professional biologist with working knowledge of heron life history, ecology and behavior, and have field experience with herons. Monitoring of the Post Point heron colony has been provided by Nahkeeta Northwest Wildlife Services since 2005. All monitoring methods, oversight, and reporting has been the responsibility of the Heron Biologist, Ann Eissinger.



Colony Monitoring - 2014

There are three general types of monitoring schemes, each with a different purpose and application.

- General monitoring: regular weekly or biweekly visits to the colony to document activity, nesting stages, and disturbances throughout the season. General monitoring incorporates regular visits with a productivity survey, foraging area survey and autumn nest count. This is the best method for on-going monitoring.

- Intensive monitoring: is a variation of general monitoring, but includes more visits for a longer duration. This method is generally used to determine or document project related disturbances and changes in heron behavior that could indicate stress or destabilization of the colony. This method is needed when the colony is exposed to planned disturbances and/or is believed to be at risk of abandonment..

- Seasonal monitoring: seasonal visits to determine occupancy only. This method should include a minimum of three-four visits to the colony, first to establish recolonization in the early spring and dates (in the event that timing information is needed for nearby project planning). Recording or estimating active nest numbers is useful. Hatching dates and productivity count are optional. Confirm full season of nesting and fledging is important. Colonies have been known to abandon mid-season and without a fledging confirmation there is no way to document that the young actually survived to fledge. Finally an annual nest count following the dropping of leaves in the autumn is essential to document actual nest numbers and track growth over time.

Monitoring methods are established and provide structure for data collection and comparison across the region by the scientific community. A detailed monitoring guide and explanation of field protocol is available from Nahkeeta Northwest: Great Blue Heron Monitoring Guidelines for Land Trusts and Other Citizen Science Programs (A. Eissinger 2013). The Heron Working Group – Survey Protocol for Measurement of Nesting Productivity of Pacific Great Blue Heron Nesting Colonies, also provides technical guidance for monitoring heron colonies (R.G. Vennesland and D. M. Norman 2006).

An abbreviated description of monitoring methods is also available in the 2003 Post Point Heron Colony Management Plan. The recommendations of the 2003 monitoring continue to be relevant.

The duration for monitoring the Post Point heron colony is February 1- September 1 or terminating when all the herons have dispersed from the colony. If early season weather conditions are fair, an earlier start date, such as January 15, may be justified to witness staging or pre-nesting heron congregations.

Important monitoring sequence and stages to document during the heron nesting season include the following.

- Pre-Season Colony Assessment
  - Record condition of colony, nests and trees, including a nest count.
- Early Season:
  - Staging
  - Colony reoccupation
  - Courtship and nest building
  - Onset of incubation
- Mid Season:
  - First hatching
  - Rearing of young

- Late Season:
    - Productivity survey – young are about 6 weeks of age
    - First fledging
    - Mass fledging if occurs
    - End of season – all herons have dispersed from colony
- Post Season Assessment
    - Autumn nest count
    - Colony mapping update
- Annual Reporting

Monitoring at Post Point has been conducted annually since 2005. General monitoring methods have been used with the exception of 2012-2014 when intensive methodology was employed due to the PPRRP expansion. The monitoring results have been summarized in periodic reports to PPRRP Supervisor and also complied and reported to the City of Bellingham in annual reports which are available online. (https://www.cob.org/services/environment/restoration/Pages/post-point-lagoon.aspx)

General monitoring of the Post Point heron colony is recommended to continue on an annual basis. The methods employed since 2005 are also recommended to continue for consistency of data, comparative tracking and overall management of the colony. Periodic reporting during the nesting season and annual reporting of results is also recommended.

6.8.1. Landuse Monitoring

One other form of monitoring is that of review of proposed landuse activities in the vicinity of the heronry. Those activities that could pose an impact or potential disturbance to the colony would likely need evaluation by a qualified biologist to provide comment. A mechanism to engage a qualified biologist in landuse project or change proposals would be helpful in the management of the colony and associated habitats.

6.9. Public Education

Recreational wildlife viewing has become a popular North American past time involving approximately 26 percent of the U.S. population in 2016, representing over twice the number of people who hunt and fish (USFWS et al, 2016). Viewing wildlife in an urban environment compounds it value by its accessibility to more people in addition to reaching broader socio-economic groups.

Many citizens of Bellingham have rallied around the Post Point heron colony and support its protection and long term viability, they also care about herons. Individuals and groups both young and old enjoy visiting the colony viewing area from the public trail. No formal survey has been conducted to record visitor numbers, but that would be recommended to inform management and assist the City in educational or outreach strategies.

In 2008 the City of Bellingham developed a series of interpretive signs which were place along the public tail between the dog park and Post Point Lagoon. The signs provided information about the herons, their habitat and life cycle. Other signs were related to pocket estuaries and their ecological value. These signs provide focal points along the trail and an area of contemplation at small viewing deck and bench between the lagoon and colony. The signs have been well received and are still viewed today. Additional information made available to the public or trained volunteers like docents for the Post Point colony would also be beneficial.

In addition to passive public viewing, it would be useful reach out to the neighborhood groups, educational groups and user groups that have a stake in Post Point and other heron habitat areas. These include both nesting and foraging areas. The purpose of meeting with these groups would be to share general information about the herons and stress the need to reduce disturbance by limiting distance from herons if encountered, and reducing potentially disturbing activities.

Due to the increasing use of shoreline areas, a review of issues and conflicts with herons would be useful. Due to known conflicts at Marine Park, an evaluation of that site and discussion related to possible actions is needed. This could include items such as informative signage, markers, barriers or other ideas to separate people from herons.

Providing an informative and educational web-presence would also be useful. An easy to access webpage or site with information about the Post Point heron colony would help inform a broader public and also assist in its protection and management.

Other educational opportunities include a webcam in the colony to stream live views of nesting herons over the internet. This has been done in other colonies in the past, but has been discontinued for various reasons. An exploratory review and feasibility study for this idea would be informative. Considerations would include: applicability and feasibility at Post Point, benefits, limitations, possible disturbance or impacts, cost, equipment, maintenance and responsibility. A reporting of this information would be a good starting point to discuss the concept and formulate next steps.

6.10. SUMMARY OF RECOMMENDATIONS

A summary of recommendations for the Post Point heron colony is listed below and are based on the full descriptions provided in Section 6 - Management and Recommendations of this document. For more detail please refer to the earlier text.

Summary of Recommendations		
Location	Activity	Protection Timing
Nesting Area	This area requires full year-round protection from disturbance and disruption, and should be off limits to unauthorized personnel. The core area requires the surrounding forest habitat to maintain the current habitat function and values.	Year-round
Nest Stand	The current nest stand serves the heron colony well and should be protected fully and kept intact. Access into the forest should be restricted on a seasonal basis.	Year-round/ Seasonal
Roosting and Loafing Areas	The roosting and loafing areas associated with the Post Point heron colony include areas of the forest stand and portions of salt marsh or shoreline around the Post Point lagoon. These areas all should be protected from human intrusion and disturbance year round when herons are present.	Year-round
Staging Areas	The staging areas for the Post Point herons including isolated pockets around the Post Point Lagoon and the western clarifiers at the PPWTP should be protected during staging activities. Seasonal protection of the herons at these locations requires awareness of the heron's presence and accommodation during their staging activities which only last 1-2 weeks in January, February or March.	Seasonal
Foraging Areas	Availability of eelgrass habitat needs to be evaluated, particularly those areas that were enhanced 10 years ago. Recommended setback distances from feeding herons are: 300 ft. for pedestrians on shore, and 590 ft. for small craft on the water. Dogs should be kept on leash when on the beach. Public education, signage and other options may assist in reducing heron disturbance while feeding and are recommended.	Year-round
Alternate Nesting Areas	WDFW Management Recommendations suggest identification of alternate nesting habitat. A minimum of 10 acres is recommended. Three sites were identified and all are located on publicly owned property. These include: Chuckanut Community Forest, Hoag's Pond, and Chuckanut Bay.	N/A
197 ft. buffer	This buffer includes the colony nucleus or nest area and an area of native vegetation, and should be a year-round no-entry/no activity area. Exemptions or provisions for certain private and public areas within the buffer need to be determined.	Year-round

300 ft. buffer	The 300 ft buffer should be a year-round habitat/vegetation protection and seasonal no disturbance zone. This buffer provides additional habitat/vegetation retention around the core zone and limits seasonal access and activity. Seasonal access and activity restrictions should apply between January 15 and September 1. Exemptions or provisions for certain private and public areas within the buffer need to be determined	Year round/ seasonal
650 ft. buffer (850 ft. from colony perimeter)	The 650 ft buffer should be a seasonal quiet buffer and extreme disturbance reduction zone. This buffer is recommended by WDFW as a quiet zone. In this area activities emitting loud noise >92 dB and other high magnitude disturbances should be restricted. The quiet zone is a priority issue for the herons.	Seasonal
Flyway and Aerial Buffer	Precautionary measures to avoid direct disturbance to the herons or damage to the colony by low-flying aircraft/drones are recommended, including: 1) seek guidance from WDFW, 2) discuss issue with local flight service professionals including the US Coast Guard stationed at Squalicum Harbor, 3) request all flights over Post Point maintain a minimum altitude of 1,000 ft, 4) create a done no-fly zone over the Post Point Heron Reserve area.	Year-round
Heron Reserve	A Heron Reserve area was proposed in 2003 and again in 2019. This Reserve would protect all of the immediate habitat necessary to support the Post Point heron colony. Feeding grounds outside of the Post Point site may also be included. The Reserve as a management approach could be applied as a means to augment recommended buffers or as a stand-alone management option focused on heron habitat protection.	Year-round
Site Restoration and Enhancement	Restoration and/or enhancement projects have been ongoing at Post Point since 2002. A thorough evaluation of mitigation actions and areas to improve heron habitat is recommended. There is a need to assess and plan restoration and enhancement of the heron nest stand and northern buffer due to tree loss in 2018-2019. A site assessment and plan development is recommended. A vegetation management plan is recommended to address maintenance activities and timing within buffers and heron habitat areas. There is a strong chemical odor emitted from the PPRRP clarifier that needs evaluation. A passive air sampler to determine the compounds being emitted would be useful. Planting a row of trees around the clarifier to absorb odor may also help mitigate the problem.	Seasonal

Site Management and Security	Site management and security for the Post Point heron colony is vitally important for the heronry's longevity. Management and oversight of the colony area and associated habitats changed in 2019 and will now be the responsibility of the Bellingham Public Works - Public Natural Resources Division. It is recommended that City personnel and heron monitoring biologist meet on a regular basis to discuss heron colony and habitat management, security, requests for access, monitoring results, project proposals, public education and outreach.	Year-round
Site Monitoring	The continuation of ongoing general monitoring of the heron colony is recommended. A foraging area survey update is also recommended.	Seasonal
Public Education	Educational recommendations include: • Survey of public trail users viewing the heron colony. • Educational out-reach to user groups and neighbors of Post Point and Marine Park as information and build appreciation for the herons and need to provide distance when sharing habitat areas, particularly beaches. • Evaluate Marine Park and associated beach for heron protection measures. • Create an easy to access, well informed website about the Post Point herons. • Explore the feasibility of placing a webcam in the heron colony and providing live streaming of the heron nesting area. • Consider a volunteer training and engagement program for heron/naturalist docents – this could be part of a roving naturalist program for the City Parks.	Year-round



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APPENDIX B.7:
SHORELINE PERMIT EXEMPTION AUTHORIZATION SHR2025-0015
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

PLANNING and COMMUNITY DEVELOPMENT DEPARTMENT
210 Lottie Street, Bellingham, WA 98225
Phone: (360) 778-8300 Fax: (360) 778-8301 TTY: (360) 778-8382
Email: planning@cob.org Web: www.cob.org

SHORELINE PERMIT EXEMPTION AUTHORIZATION for TYPE I PROJECTS

SHR: SHR2025-0015 Date Issued: 12/17/25

Project Address and Parcel #: 200 McKenzie Ave., Bellingham WA 98225 Fairhaven Urban Village, Public 2 zoning Parcel Number(s) 370211-403538 & 370202-452038

Applicant and Contact Information: Stephen Day P.E., S.E. City of Bellingham Project Engineer – Plants, 104 W. Magnolia St. Suite 109, Bellingham WA 98225

Project Description: Construction of a new and similar sized set of tanks and associated infrastructure within the existing wastewater plant boundary to replace the existing tank and restore operational reliability. Proposed project elements include the following: Demolition of the abandoned Chlorine Building 420; Construction of two new 50,000 gallon concrete tanks and a biotrickling filter/odor control system in the approximate location of the Chlorine Building 420; Site restoration/stormwater/yard piping around the new sludge storage tanks and odor control; Repurpose the existing Chlorine Scrubber Building to support the new mechanical and electrical infrastructure associated with the new sludge storage tanks; Structural modifications include adding exterior doors, extending the grade-level floor across the building and roof material replacement; Demolition of the existing sludge storage tank inside Building 510; Replacement of thickened sludge pumps and associated piping inside the Building 530 basement; Demolition of existing waste activated sludge pumps and addition of a new dewatering pump inside the Building 340 basement; Replacement of two existing return activated sludge pumps and piping; Piping modifications between the new sludge storage tanks and the secondary pump station; and Construction of new replacement waste activated sludge pumps.

Shoreline Designation and Reach #: Urban Conservancy (Pocket Estuary) Shoreline Designation, Reach 13

Buffer Width: 200’ Conforming Use: Yes, Public Wastewater Treatment Facility

Conforming Development: (Buffer, height, etc.) Portions of the existing Public Wastewater Treatment Facility are located within the required 200’ buffer.

Associated Development Permit #(s): SEP2025-0021, BLD2025-0832, STM2025-0111

Exempt pursuant to BMC 22.05.020.B.1.b: Normal maintenance or repair of existing structures or developments. Within the 200’ shoreline buffer, the project elements are limited to interior equipment modifications to the existing handling building (bldg. 510). No exterior modifications, staging, storage or transport will occur within the shoreline buffer.

Rationale: The proposal is maintenance and repair of the existing wastewater treatment facility. The replacement of the 80,000 gallon sludge storage tank with 2 smaller tanks (100,000 gallon total) and building demolition are located outside of shoreline jurisdiction. The proposed work within shoreline jurisdiction is limited to interior renovations to existing buildings and utility work essential for continued operation of public wastewater treatment facility consistent with the shoreline exemption for normal maintenance.

PLANNING and COMMUNITY DEVELOPMENT DEPARTMENT
210 Lottie Street, Bellingham, WA 98225
Phone: (360) 778-8300 Fax: (360) 778-8301 TTY: (360) 778-8382
Email: planning@cob.org Web: www.cob.org

Condition(s): None under the shoreline exemption. Conditions for compliance with the applicable development regulations will be applied under the associated construction permits.

Exempt from SEPA pursuant to WAC 197-11-800: Determination of Non-significance issued under SEP2025-0021

Authorized By: 

Expiration: This Type I permit shall expire two years from the date of decision unless a complete building permit application (or similar) is filed before the expiration date as specified in BMC 21.10.260 C 1.

Appeal: Any party aggrieved by the decision of the Director may file an appeal within 14 days of the decision on this permit in accordance with BMC 21.10.250. Any appeal must be filed with the Planning and Community Development Department on the appropriate forms and be accompanied by a filing fee as established by the City Council.

APPENDIX B.8:
NWCAA ORDER OF APPROVAL TO CONSTRUCT OAC 1437
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

Original Issuance: June 24, 2026

Northwest Clean Air Agency (NWCAA) hereby issues
Order of Approval to Construct (OAC) 1437

Project Summary: Replacement of the existing sewage sludge tank with two 50,000-gallon sewage sludge storage tanks.

Approved Emission Units:

- Two (2) 50,000-gallon sludge storage tanks. Exhaust air is controlled using a biotrickling filter system rated for approximately 1,000 cfm.

Owner/Operator	Facility Name and Location
City of Bellingham Department of Public Works 200 McKenzie Street Bellingham, Washington 98225 Contact: Nickolas Leininger, Superintendent of Operations	Post Point Wastewater Treatment Plant 200 McKenzie Street Bellingham, Washington 98225

Note that in addition to other applicable rules and regulations, the approved emission units are subject to applicable portions of the following regulations:

NWCAA Regulation

- Section 462 – Emission of sulfur compounds
- Section 535 – Odor control measures

Issuance of this Order is authorized by Northwest Clean Air Agency Regulation Section 300. The Owner/Operator must comply with the following restrictions and conditions[1]:

(1) Nuisance odors from the facility are prohibited at or beyond the property boundary as determined by NWCAA staff.

[1] Nothing in this permit is intended to, or shall, alter or waive any applicable law [including but not limited to defenses, entitlements, challenges or clarifications related to the Credible Evidence Rule, 62 FR 8315 (Feb. 27, 1997)] concerning the use of data for any purpose under the Act, generated by the reference method specified herein or otherwise.

Pursuant to Section 300.10 of the NWCAA Regulation and Ch 43.21B RCW, this Order may be appealed to the Pollution Control Hearings Board (PCHB). To appeal to the PCHB, a written notice of appeal must be filed with the PCHB and a copy served upon the NWCAA within 30 days of the date the applicant receives this Order. Additional information regarding appeal procedures can be found at: http://www.eluho.wa.gov/ under PCHB.

(2) Except for times of routine maintenance or repair, operate the biotrickling filter at all times the sewage sludge tanks are in operation and route all air emissions from the sewage sludge tanks through the biotrickling filter.

(3) Develop a written operation and maintenance manual for the sewage sludge tank ventilation and biotrickling filtration systems including internal inspection schedules, maintenance requirements, and operating procedures. Maintain the manual onsite and make it readily available for inspection by NWCAA staff.

(4) Maintain and operate the biotrickling filter system in accordance with the manufacturer's specifications and associated operation and maintenance manuals. Record all maintenance activities performed on the biotrickling filter system.

(5) Install a pressure differential measurement device across the biotrickling filter system. Locate the gauge in an easily accessible location for operators and NWCAA inspection. Determine, using established manufacturer recommendations, or through engineering judgment the acceptable range of differential pressure across the biotrickling filter. Post the acceptable range within view of the differential pressure gauge.

(6) Check and record the pressure differential once per operating week, for any week in which the system operates. If the biotrickling filtration system is operating outside the acceptable range, notify NWCAA within 24 hours and proceed with corrective actions immediately.

(7) At no time may emissions from the biotrickling filtration system's exhaust exceed one (1) part per million by volume (ppmv)of hydrogen sulfide (H_2S).

(8) Once per month, measure & record the hydrogen sulfide (H_2S) emissions using a colorimetric detector tube or other method approved in writing by NWCAA. After six (6) months of consecutive compliant measurements, Post Point Wastewater Treatment Plant may reduce sampling to quarterly testing, separated by at least 60 days. If any measurement indicates an exceedance of the limit, notify NWCAA within 24 hours and begin corrective actions. After a non-compliant measurement, Post Point Wastewater Treatment Plant must return to monthly sampling, until six consecutive compliant measurements are demonstrated.

(9) Maintain all records required by this Order onsite for no less than 3 years from the date of generation and keep readily available for review by NWCAA personnel.

(10) Provide written notice to the NWCAA of the date of initial startup of the sewage sludge tanks and biotrickling filter system. Electronically submit this notification to FacilityReports@NWCleanAirWA.gov no later than 15 days after startup and include a reference to OAC 1437.

Jason Bouwman
Chemist

Agata McIntyre, P.E.
Engineering Manager

APPENDIX B.9:
NWCAA ASBESTOS/DEMOLITION NOTIFICATION APPROVAL
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

This Appendix includes the following relevant documents, reference Special Provision 1-07.6.:

B.9 Exhibit A: Asbestos Containing Material and Lead Based Paint Survey Reports, All4 Inc., 3/5/2025 & 3/21/2025

northwest Clean Air agency
1600 S 2nd Street
Mount Vernon, WA 98273
Main: 360-428-1617
Fax: 360-428-1620
info@nwcleanairwa.gov
nwcleanairwa.gov

Asbestos / Demolition Notification Approval and Permit to Work

Notification #	25-481
Received Date	09/17/2025
Approval Date	09/25/2025
Fee Amount	$ 280.00
Receipt #	001977

Project Site

Post Point WWTP Building 420
200 McKenzie St
Bellingham, 98225

Project Details

Project Type Demolition only

Building Type Other Industrial - Wastewater Treatment Plant unused Building

☐ **Emergency**

Estimated Demolition Date 06/01/2026

☑ **Survey**

Survey Link [Survey on file with NWCAA]

☐ **Owner Occupied Abatement**

Asbestos Locations

☐ **Class I** ☐ **Class II** ☐ **Vermiculite** ☐ **Non-friable Fee Exempt Material**

Owner

Site Owner City of Bellingham Finance Dept Asset Division

Owner Phone (360) 778-7944

Notification Submitted by Stephen Day
Notification Contact Phone (360) 778-7944
Notification Contact Email smday@cob.org

This notification must be posted at the work site.

You must file an amendment if there are any changes to the project scope or schedule.
<http://nwcleanairwa.gov/forms/asbestos-project-amendment/>

Information on asbestos and demolition can be found on the agency website.
<http://nwcleanairwa.gov/permits-and-services/asbestos-and-demolition/>

Asbestos disposal information
<http://nwcleanairwa.gov/download/disposal-information/>

NWCAA asbestos regulations can be found in Section 570 Asbestos Control Standards.
<http://nwcleanairwa.gov/regulation/section-550-590/section-570/>

APPENDIX B.9 EXHIBIT A:
ASBESTOS CONTAINING MATERIAL AND LEAD BASED PAINT SURVEY REPORTS
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

March 5, 2025

Mr. Stephen Day
City of Bellingham
210 Lottie St.
Bellingham, WA 98225

Re: Asbestos Containing Material and Lead Based Paint Survey – Post Point Wastewater Treatment Plant – 200 McKenzie Avenue, Bellingham, WA

Mr. Day:

ALL4 LLC has performed an asbestos containing material (ACM) and lead based paint (LBP) survey at the Post Point Wastewater Treatment Plant (Facility) located at 200 McKenzie Avenue in Bellingham, Washington (Subject Property).

SCOPE OF WORK

This survey evaluated client-specified areas at the Facility for potential asbestos containing material and lead based paint. The intent of this survey was to comply with the requirement of a "good faith inspection" in conjunction with redevelopment work being considered at the subject property. The inspection results also provide information to employees and contractors that may disrupt suspected materials.

The survey was conducted on February 18, 2025, by Mr. Thomas Davis. Mr. Davis is a registered Asbestos Hazard Emergency Response Act (AHERA) Asbestos Building Inspector (Certification #: NES-BIR-20240826-21) and a Certified Lead Inspector (Certification #: 6063). The survey was conducted by visually evaluating building materials in all accessible areas of the Chlorine Building, Chlorine Scrubber building, the Pipe Gallery, the RAS Pump room, and the Solids Tank area of the Post Point wastewater treatment facility. Representative suspect building materials were sampled and analyzed for potential ACM. The survey was limited to 'visible and accessible' suspected asbestos-containing building materials.

Samples of suspect building materials were analyzed using Polarized Light Microscopy by EPA Method 600/R-93/116 at NVL Laboratories in Seattle, Washington. For samples containing more than one layer of material, the laboratory identified each layer individually and provided a total percentage of asbestos contained in each layer.

A portable handheld SciAps X-550 Pb X-ray Fluorescence (XRF) device was used to evaluate painted surfaces in-situ for the presence of LBP.

ALL4 • info@all4inc.com • www.all4inc.com

STRATEGY WITH SOLUTION. PARTNERSHIP WITH A PURPOSE.

ASBESTOS CONTAINING MATERIAL RESULTS

Thirteen bulk asbestos samples were collected from wall material, caulking material, piping gasket material, and other miscellaneous suspect building materials observed in the Facility. A roof core sample was not collected due to no available access point.

ACM was not identified in any of the thirteen samples collected.

All ACM sample locations are shown on Figure 1 and described in Table 1 - ACM Sample Analytical Results. The original Method 600/R-93/116 asbestos analytical data report is included in Appendix A.

LEAD BASED PAINT RESULTS

One hundred and eighty painted surfaces were tested using the XRF device. Seventeen paint colors were tested including: black, blue, blue-gray, brown, dark green, gold, gray, green, greenish blue, light blue, orange, red, reddish-brown, silver, tan, white, and yellow paints.

The yellow-colored industrial paint associated with curbs and safety signage was identified as LBP. LBP is defined as a paint, or surface coating, that contains greater than, or equal to, 1 mg/cm^2 lead by area when using the XRF method of analysis. The yellow paint identified as LBP in the facility contained an average of 2.4 mg/cm^2 lead by area.

One small area of tan colored paint was identified as LBP. The tan paint was located on a vertical pipe located near the large set of doors in the open area of the chlorine building. Not all areas of the tan painted pipe registered on the XRF as LBP. It may be that the pipe was painted recently, and the new paint is hiding some of the yellow-colored industrial paint described above.

The locations where LBP was identified are shown in Figure 1. The complete XRF test shot output data record sheet is included in Appendix B.

CONCLUSIONS

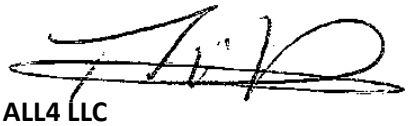
No ACM was identified as part of this survey.

The safety-yellow colored paint located primarily in the Chlorine Building was identified as LBP. The paint was associated with curbs, EXT signs, and door thresholds.

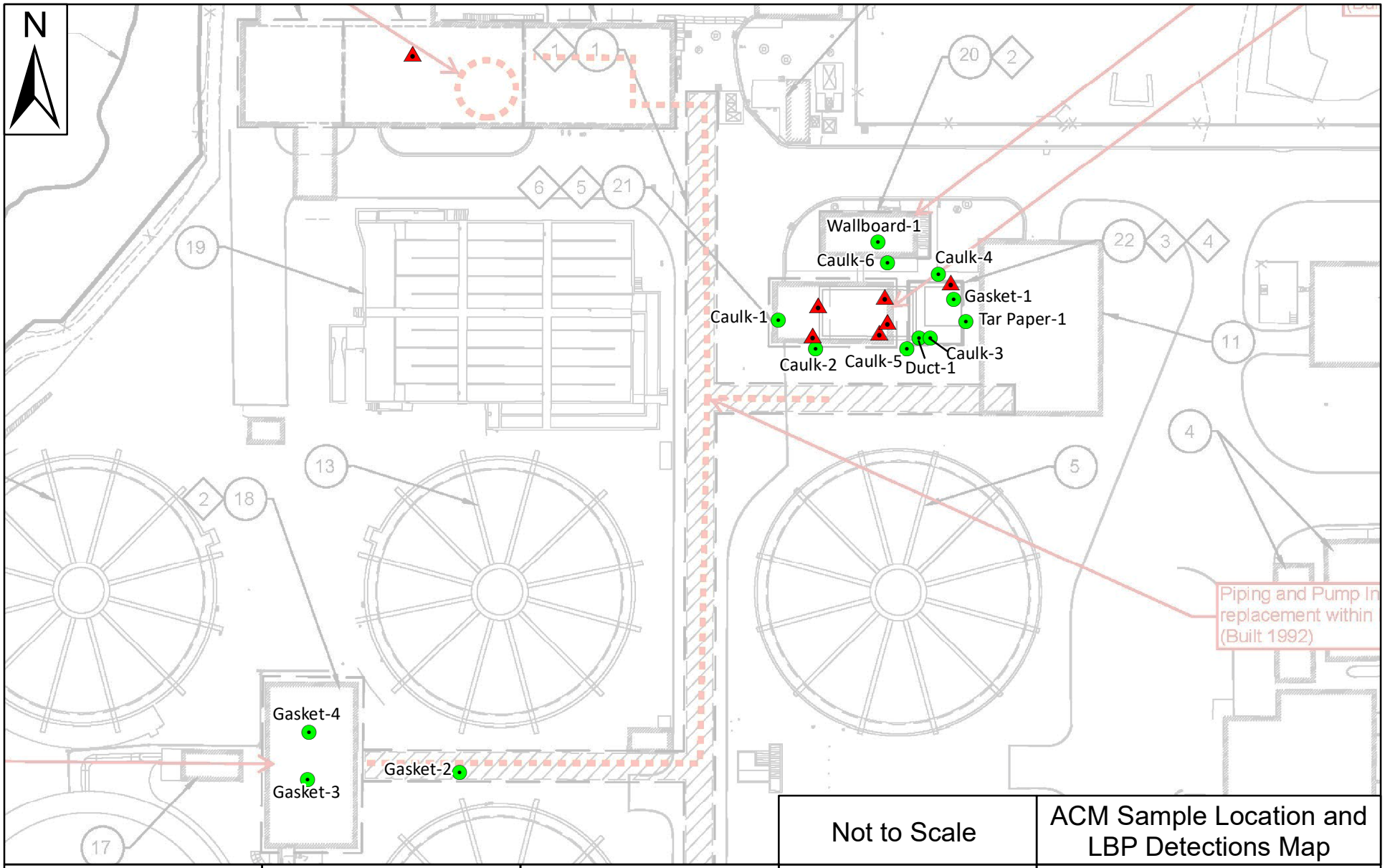
A small area of tan colored paint located on a vertical pipe in the chlorine building was identified as LBP. Tan paint observed and tested in other areas of the facility did not register as LBP on the XRF, so it may be that an older layer of safety-yellow paint is present beneath the tan paint.

On behalf of ALL4 LLC, I appreciate the opportunity to provide the City of Bellingham with this ACM/LBP survey for the Post Point treatment facility in Bellingham, Washington. If you have any questions regarding the report's findings, please call me at (360) 752-9571.

Sincerely,



ALL4 LLC
Thomas Davis, L.G. – Consulting Scientist
AHERA Building Inspector Certification #: NES-BIR-20240826-21
Lead Inspector Certification #: 6063



Not to Scale

ACM Sample Location and LBP Detections Map

LBP Test Locations

Identified as LBP

ACM Samples

Non-Detect for ACM

All data are approximate and should be used for relative location reference only.

Base Map provided by:
The City of Bellingham

Prepared for:

Prepared by:

ALL4

200 McKenzie Avenue
Bellingham, WA 98225

Post Point ACM/LBP

02/26/2025

Figure 1

Table 1
ACM Sample Analytical Results
200 McKenzie Avenue, Bellingham, WA
Post Point Waste Water Treatment Plant

Sample ID	Date	Sample Location and Description	Analytical Result (%)	Designation[(a)]
Samples listed in the order collected.				
Caulk-1	2/18/2025	Collcted from the caulking material located on the south side of the double doors on the western side of the old chlorine tank building.	ND	Not ACM
Caulk-2	2/18/2025	Collected from the brown painted caulking material located on the exterior door frame on the south side of the building, on the eastern upright of the door.	ND	Not ACM
Gasket-1	2/18/2025	Collected from pipe gasket material located at the east end of the chlorine building on a capped-off ~4-in. Pipe near the back door, in the east section of the chlorine building.	ND	Not ACM
Caulk-3	2/18/2025	Collected from silver painted caulking material located on the edge of the heater unit in the east section of the chlorine building.	ND	Not ACM
Caulk-4	2/18/2025	Collcted from exterior caulking material located on the north side of the chlorine building.	ND	Not ACM
Tar Paper-1	2/18/2025	Collected from exposed tar paper material located at the eastern exterior door frame exterior on the chlorine building.	ND	Not ACM
Caulk-5	2/18/2025	Collected from exterior caulking material located at the edge of the heater unit on the southern exterior of the chlorine building.	ND	Not ACM
Duct-1	2/18/2025	Collected from the coating material located on the rectangular ducting in the east section of the chlorine building.	ND	Not ACM
Wallboard-1	2/18/2025	Collected from the drywall wallboard material located in the stairs area of the chlorine scrubber building.	ND	Not ACM
Caulk-6	2/18/2025	Collected from caulking material located on the southern exterior of the chlorine scrubber building.	ND	Not ACM
Gasket-2	2/18/2025	Collected from black rubber gasket material at a joint on the RAS Line located in the pipe gallery.	ND	Not ACM
Gasket-3	2/18/2025	Collected from a "greenish" colored gasket material located at RAS pump 3 in the RAS pump room.	ND	Not ACM
Gasket-4	2/18/2025	Collected from a beige gasket material located in the northern section of the RAS pump room.	ND	Not ACM

[(a)] Asbestos containing material is defined as a building material containing >1.0% asbestos by weight

ND - indicates analyte was Not Detected at level above reporting limit (shown in parentheses)

APPENDIX A

Asbestos Containing Material Laboratory Analytical Report
(Method EPA 600/R-93/116)

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STRATEGY WITH SOLUTION. PARTNERSHIP WITH A PURPOSE.

February 24, 2025

INDUSTRIAL HYGIENE SERVICES
LABORATORY + MANAGEMENT + TRAINING

Thomas Davis
All4 LLC
228 E Champion St #101
Bellingham, WA 98225

RE: Bulk Asbestos Fiber Analysis; NVL Batch # 2503167.00

Client Project: COB Post Point ACM 004529-0002.00
Location: Post Point WWTP Bellingham, WA

Dear Mr. Davis,

Enclosed please find test results for the 13 sample(s) submitted to our laboratory for analysis on 2/19/2025.

Examination of these samples was conducted for the presence of identifiable asbestos fibers using polarized light microscopy (PLM) with dispersion staining in accordance with **U. S. EPA 40 CFR Appendix E to Subpart E of Part 763**, Interim Method for the Determination of Asbestos in Bulk Insulation Samples and **EPA 600/R-93/116**, Method for the Determination of Asbestos in Bulk Building Materials.

For samples containing more than one separable layer of materials, the report will include findings for each layer (labeled Layer 1 and Layer 2, etc. for each individual layer). The asbestos concentration in the sample is determined by calibrated visual estimation.

For those samples with asbestos concentrations between 1 and 10 percent based on visual estimation, the EPA recommends a procedure known as point counting (NESHAPS, 40 CFR Part 61). Point counting is a statistically more accurate means of quantification for samples with low concentrations of asbestos.

The detection limit for the calibrated visual estimation is <1%, 400 point counts is 0.25% and 1000 point counts is 0.1%

Samples are archived for two weeks following analysis. Samples that are not retrieved by the client are discarded after two weeks.

Thank you for using our laboratory services. Please do not hesitate to call if there is anything further we can assist you with.

Sincerely,

Muhammad Yousuf, Senior Laboratory Analyst

NVLAP
Testing
Lab Code: 102063-0

Enc.: Sample Results

Phone: 206 547.0100 | Fax: 206 634.1936 | Toll Free: 1.888.NVL.LABS (685.5227)
4708 Aurora Avenue North | Seattle, WA 98103-6516

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: All4 LLC
Address: 228 E Champion St #101
Bellingham, WA 98225

Attention: Mr. Thomas Davis
Project Location: Post Point WWTP Bellingham, WA

Batch #: 2503167.00
Client Project #: COB Post Point ACM 004529-0002.00
Date Received: 2/19/2025
Samples Received: 13
Samples Analyzed: 13
Method: EPA/600/R-93/116

Lab ID: 250018437 **Client Sample #: Caulk-1**

Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Brown soft material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Fine particles, Caulking compound, Debris	Cellulose 22%	**None Detected ND**
Fine grains, Wood flakes		

Lab ID: 250018438 **Client Sample #: Caulk-2**

Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Light gray soft rubbery material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Fine particles, Caulking compound, Debris	Cellulose 1%	**None Detected ND**
Fine grains, Insect parts		

Lab ID: 250018439 **Client Sample #: Gasket-1**

Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Black rubbery material with white woven inner fibers and paint

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Paint, Rubber/Binder, Fine particles	Synthetic fibers 12%	**None Detected ND**
	Cellulose 9%	

Lab ID: 250018440 **Client Sample #: Caulk-3**

Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Light gray soft elastic material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Fine particles, Caulking compound, Debris	Cellulose 2%	**None Detected ND**
Fine grains		

Sampled by: Client
Analyzed by: Alex Shea **Date:** 02/21/2025
Reviewed by: Muhammad Yousuf **Date:** 02/24/2025

Muhammad Yousuf, Senior Laboratory Analyst

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and EPA 40 CFR Appendix E to Subpart E of Part 763 with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: All4 LLC
Address: 228 E Champion St #101
Bellingham, WA 98225

Attention: Mr. Thomas Davis
Project Location: Post Point WWTP Bellingham, WA

Batch #: 2503167.00
Client Project #: COB Post Point ACM 004529-0002.00
Date Received: 2/19/2025
Samples Received: 13
Samples Analyzed: 13
Method: EPA/600/R-93/116

Lab ID: 250018441 **Client Sample #: Caulk-4**
Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Light gray soft material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Fine particles, Caulking compound, Debris	Cellulose 16%	**None Detected ND**
Wood flakes, Fine grains		

Lab ID: 250018442 **Client Sample #: Tar Paper-1**
Location: Post Point WWTP Bellingham, WA

Layer 1 of 2 **Description:** Black asphaltic fibrous felt

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Asphalt/Binder, Asphaltic Particles, Fine grains	Cellulose 60%	**None Detected ND**

Layer 2 of 2 **Description:** Light gray soft material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Fine particles, Caulking compound, Debris	Cellulose 4%	**None Detected ND**
Fine grains		

Lab ID: 250018443 **Client Sample #: Caulk-5**
Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Gray soft material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Fine particles, Caulking compound, Fine grains	Cellulose 2%	**None Detected ND**
Debris		

Lab ID: 250018444 **Client Sample #: Duct-1**
Location: Post Point WWTP Bellingham, WA

Sampled by: Client
Analyzed by: Alex Shea **Date:** 02/21/2025
Reviewed by: Muhammad Yousuf **Date:** 02/24/2025

Muhammad Yousuf, Senior Laboratory Analyst

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and EPA 40 CFR Appendix E to Subpart E of Part 763 with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: All4 LLC
Address: 228 E Champion St #101
Bellingham, WA 98225

Attention: Mr. Thomas Davis
Project Location: Post Point WWTP Bellingham, WA

Batch #: 2503167.00
Client Project #: COB Post Point ACM 004529-0002.00
Date Received: 2/19/2025
Samples Received: 13
Samples Analyzed: 13
Method: EPA/600/R-93/116

Layer 1 of 1 **Description:** Light gray crumbly material with fibers

Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
Binder/Filler, Fine particles, Plastic	Glass fibers	9%	**None Detected ND**
	Cellulose	2%	

Lab ID: 250018445 **Client Sample #: Wallboard-1**

Location: Post Point WWTP Bellingham, WA

Layer 1 of 2 **Description:** Thin layer of white powdery material with paint

Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
Paint, Binder/Filler, Fine particles	None Detected	ND	**None Detected ND**

Layer 2 of 2 **Description:** White chalky material with paper

Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
Fine particles, Gypsum/Binder, Fine grains	Cellulose	16%	**None Detected ND**
	Glass fibers	5%	

Lab ID: 250018446 **Client Sample #: Caulk-6**

Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Brown soft rubbery material with paint and debris

Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
Paint, Fine particles, Caulking compound	Cellulose	1%	**None Detected ND**
Debris, Fine grains			

Lab ID: 250018447 **Client Sample #: Gasket-2**

Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Black rubbery material with paint and white adhesive

Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
Paint, Rubber/Binder, Adhesive/Binder	Cellulose	2%	**None Detected ND**

Sampled by: Client
Analyzed by: Alex Shea **Date:** 02/21/2025
Reviewed by: Muhammad Yousuf **Date:** 02/24/2025

Muhammad Yousuf, Senior Laboratory Analyst

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and EPA 40 CFR Appendix E to Subpart E of Part 763 with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: All4 LLC
Address: 228 E Champion St #101
Bellingham, WA 98225

Attention: Mr. Thomas Davis
Project Location: Post Point WWTP Bellingham, WA

Batch #: 2503167.00
Client Project #: COB Post Point ACM 004529-0002.00
Date Received: 2/19/2025
Samples Received: 13
Samples Analyzed: 13
Method: EPA/600/R-93/116

Fine grains

Lab ID: 250018448 **Client Sample #: Gasket-3**

Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Green compressed fibrous material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine particles, Debris	Synthetic fibers 44%	**None Detected ND**
Fine grains	Glass fibers 22%	

Lab ID: 250018449 **Client Sample #: Gasket-4**

Location: Post Point WWTP Bellingham, WA

Layer 1 of 1 **Description:** Green and tan compressed fibrous material

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine particles, Fine grains	Cellulose 42%	**None Detected ND**
	Synthetic fibers 32%	

Sampled by: Client
Analyzed by: Alex Shea **Date:** 02/21/2025
Reviewed by: Muhammad Yousuf **Date:** 02/24/2025

Muhammad Yousuf, Senior Laboratory Analyst

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and EPA 40 CFR Appendix E to Subpart E of Part 763 with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government

ASBESTOS LABORATORY SERVICES

Company	All4 LLC	**NVL Batch Number**	**2503167.00**
Address	228 E Champion St #101 Bellingham, WA 98225	**TAT** 5 Days	**AH** No
		Rush TAT	
Project Manager	Mr. Thomas Davis	**Due Date** 2/26/2025	**Time** 9:55 AM
Phone	(360) 752-9571	**Email**	tdavis@all4inc.com
Cell	(253) 906-6648	**Fax**	(360) 752-9573

Project Name/Number: COB Post Point
ACM 004529 **Project Location:** Post Point WWTP Bellingham, WA

Subcategory PLM Bulk

Item Code ASB-02 EPA 600/R-93-116 Asbestos by PLM <bulk>

Total Number of Samples 13 Rush Samples

	Lab ID	Sample ID	Description	A/R
1	250018437	Caulk-1		A
2	250018438	Caulk-2		A
3	250018439	Gasket-1		A
4	250018440	Caulk-3		A
5	250018441	Caulk-4		A
6	250018442	Tar Paper-1		A
7	250018443	Caulk-5		A
8	250018444	Duct-1		A
9	250018445	Wallboard-1		A
10	250018446	Caulk-6		A
11	250018447	Gasket-2		A
12	250018448	Gasket-3		A
13	250018449	Gasket-4		A

	Print Name	Signature	Company	Date	Time
Sampled by	Client				
Relinquished by	UPS				

Office Use Only	Print Name	Signature	Company	Date	Time
Received by	Laura Carcone		NVL	2/19/25	0955
Analyzed by	Alex Shea		NVL	2/21/25	
Results Called by					
☐ **Faxed** ☐ **Emailed**					

Special Instructions:

Date: 2/19/2025
Time: 10:28 AM
Entered By: Laura Carcone

2503167

NVL
INDUSTRIAL HYGIENE SERVICES
LABORATORY + MANAGEMENT + TRAINING

ASBESTOS CHAIN OF CUSTODY

urn Around Time
- ❑ 1 Hour
- ❑ 2 Hours
- ❑ 4 Hours
- ❑ 24 Hours
- ❑ 2 Days
- ❑ 3 Days
- ❑ 4 Days
- ☒ 5 Days
- ❑ 10 Days

Please call for TAT less than 24 Hours

Company ALL4 Inc.
Address 228 East Champion Street, Suite #101
Bellingham, WA 98225
Phone (360) 752-9571

Project Manager Thom Davis
Cell (253) 906 - 6648
Email tdavis@all4inc.com
Fax ( ) -

Project Name/Number COB: Post Point ACM 004529-0002.00
Project Location Post Point WWTP Bellingham, WA

- ❑ PCM Air (NIOSH 7400)
- ☒ PLM (EPA 600/R-93-116)
- ❑ PLM Gravimetry (600/R-93-116)
- ❑ Asbestos Friable/Non-Friable (EPA 600/R-93/116)
- ❑ TEM (NIOSH 7402)
- ❑ EPA 400 Points (600/R-93-116)
- ❑ Asbestos in Vermiculite (EPA 600/R-04/004)
- ❑ TEM (AHERA)
- ❑ Other
- ❑ TEM (EPA Level II Modified)
- ❑ EPA 1000Points (600/R-93-116)
- ❑ Asbestos in Sediment (EPA 1900 Points)

Reporting Instructions
❑ Call ( ) - ❑ Fax ( ) - ☒ Email

Total Number of Samples 13

	Sample ID	Description	A/R
1	Caulk-1		
2	Caulk-2		
3	Gasket-1		
4	Caulk-3		
5	Caulk-4		
6	Tar Paper-1		
7	Caulk-5		
8	Duct-1		
9	Wallboard-1		
10	Caulk-6		
11	Gasket-2		
12	Gasket-3		
13	Gasket-4		
14			
15			

	Print Name	Signature	Company	Date	Time
Sampled by	Thom Davis		ALL4	February 18, 2025	1430
Relinquish by					

Office Use Only

	Print Name	Signature	Company	Date	Time
Received by	LAURA C		NVL	2/19/25	0955 UPS
Analyzed by					
Called by					
Faxed/Email by					

APPENDIX B

Lead Based Paint XRF Shot Database
(SciAps X-550 Pb XRF)

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STRATEGY WITH SOLUTION. PARTNERSHIP WITH A PURPOSE.

Date	Test #	Mode	Action Level	Pb (mg/cm2)	Pb P/F	SITE	Location	SIDE	Color	Component	Substrate
2/18/2025 9:29	9	Lead Paint (Timed)	1	1.083	Positive	Post Point	Calibrate In		NIST 1.03PPM		Wood
2/18/2025 9:30	13	Lead Paint (Timed)	1	0.001	Negative	Post Point	Cal in		NIST Blank		Wood
2/18/2025 9:30	14	Lead Paint (Timed)	1	ND	Negative	Post Point	Cal in		NIST Blank		Wood
2/18/2025 9:30	15	Lead Paint (Timed)	1	ND	Negative	Post Point	Cal in		NIST Blank		Wood
2/18/2025 9:30	16	Lead Paint (Timed)	1	ND	Negative	Post Point	Cal in		NIST Blank		Wood
2/18/2025 9:30	11	Lead Paint (Timed)	1	1.1	Positive	Post Point	Cal in		NIST 1.03PPM		Wood
2/18/2025 9:30	12	Lead Paint (Timed)	1	1.115	Positive	Post Point	Cal in		NIST 1.03PPM		Wood
2/18/2025 9:30	10	Lead Paint (Timed)	1	1.163	Positive	Post Point	Cal in		NIST 1.03PPM		Wood
2/18/2025 9:31	17	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg	W	Brown	Door	Steel
2/18/2025 9:32	18	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg	W	Brown	Door	Steel
2/18/2025 9:33	20	Lead Paint (Quick)	1	0.047	Negative	Post Point	Chlor Bldg	W	Tan.	Wall	Wood.
2/18/2025 9:33	19	Lead Paint (Quick)	1	0.054	Negative	Post Point	Chlor Bldg	W	Tan.	Wall	Wood.
2/18/2025 9:34	21	Lead Paint (Quick)	1	0.042	Negative	Post Point	Chlor Bldg	S	Tan.	Wall	Wood.
2/18/2025 9:34	22	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg	S	Tan.	Wall	Wood.
2/18/2025 9:35	**23**	**Lead Paint (Quick)**	**1**	**1.22**	**Positive**	**Post Point**	**Chlor Bldg**	**S**	**Tan.**	**Pipe**	**Steel**
2/18/2025 9:36	25	Lead Paint (Quick)	1	0.665	Negative	Post Point	Chlor Bldg	S	Tan.	Pipe	Steel.
2/18/2025 9:36	24	Lead Paint (Quick)	1	0.891	Negative	Post Point	Chlor Bldg	S	Tan.	Pipe	Steel.
2/18/2025 9:36	**26**	**Lead Paint (Quick)**	**1**	**1.103**	**Positive**	**Post Point**	**Chlor Bldg**	**S**	**Tan.**	**Pipe**	**Steel**
2/18/2025 9:37	27	Lead Paint (Quick)	1	0.026	Negative	Post Point	Chlor Bldg	E	Brown.	Door	Steel.
2/18/2025 9:38	28	Lead Paint (Quick)	1	0.021	Negative	Post Point	Chlor Bldg	E	Brown.	Door	Steel.
2/18/2025 9:38	29	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg	E	Brown.	Wall	Wood.
2/18/2025 9:39	31	Lead Paint (Quick)	1	0.185	Negative	Post Point	Chlor Bldg	E	Yellow.	Floor In Front Of Door	Concrete.
2/18/2025 9:39	**30**	**Lead Paint (Quick)**	**1**	**2.783**	**Positive**	**Post Point**	**Chlor Bldg**	**E**	**Yellow.**	**Floor In Front Of Door**	**Concrete**
2/18/2025 9:40	32	Lead Paint (Quick)	1	0.291	Negative	Post Point	Chlor Bldg	E	Yellow.	Floor In Front Of Door	Concrete.
2/18/2025 9:40	**33**	**Lead Paint (Quick)**	**1**	**1.204**	**Positive**	**Post Point**	**Chlor Bldg**	**E**	**Yellow.**	**Floor In Front Of Door On N Side**	**Concrete.**
2/18/2025 9:41	**34**	**Lead Paint (Quick)**	**1**	**2.234**	**Positive**	**Post Point**	**Chlor Bldg**	**E**	**Yellow.**	**Floor In Front Of Door On N Side**	**Concrete.**
2/18/2025 9:41	**35**	**Lead Paint (Quick)**	**1**	**3.226**	**Positive**	**Post Point**	**Chlor Bldg**	**E**	**Yellow.**	**Floor In Front Of Door On S Side**	**Concrete.**
2/18/2025 9:42	36	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg		Red.	Beam, Support	Steel.
2/18/2025 9:43	38	Lead Paint (Quick)	1	0.166	Negative	Post Point	Chlor Bldg	N	Tan.	Wall	Wood.
2/18/2025 9:43	37	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg		Red.	Beam, Support	Steel.
2/18/2025 9:44	40	Lead Paint (Quick)	1	0.691	Negative	Post Point	Chlor Bldg	N	Tan.	Pipe	Steel.
2/18/2025 9:44	41	Lead Paint (Quick)	1	0.749	Negative	Post Point	Chlor Bldg	N	Tan.	Pipe	Steel.
2/18/2025 9:44	39	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg	N	Tan.	Wall	Wood.
2/18/2025 9:45	42	Lead Paint (Quick)	1	0.915	Negative	Post Point	Chlor Bldg	N	Tan.	Pipe	Steel.
2/18/2025 9:46	43	Lead Paint (Quick)	1	0.296	Negative	Post Point	Chlor Bldg	N	Red.	Water Pipe	Steel.
2/18/2025 9:49	44	Lead Paint (Quick)	1	0.026	Negative	Post Point	Chlor Bldg	Up	White.	2 Ton Hoist Track Beam	Steel.
2/18/2025 9:50	45	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg	Up	White.	2 Ton Hoist Track Beam	Steel.
2/18/2025 9:51	47	Lead Paint (Quick)	1	0.011	Negative	Post Point	Chlor Bldg		Blue Gray.	Roof	Steel.
2/18/2025 9:51	46	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg	Up	Blue Gray.	Roof	Steel.
2/18/2025 9:53	**48**	**Lead Paint (Quick)**	**1**	**4.373**	**Positive**	**Post Point**	**Chlor Bldg**	**W**	**Yellow**	**Curb Paint**	**Concrete.**
2/18/2025 10:06	49	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg	E	Black	Door Stop Thing	Concrete.
2/18/2025 10:35	50	Lead Paint (Quick)	1	0.02	Negative	Post Point	Chlor Bldg Interior	W	Brown	Door	Steel.
2/18/2025 10:35	51	Lead Paint (Quick)	1	0.033	Negative	Post Point	Chlor Bldg Interior	W	Tan	Wall	Steel.
2/18/2025 10:36	53	Lead Paint (Quick)	1	0.049	Negative	Post Point	Chlor Bldg Interior	E	Tan	Wall	Wood
2/18/2025 10:36	52	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	S	Tan	Wall	Wood
2/18/2025 10:37	54	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	E	White	Window Frame	Wood

Date	Test #	Mode	Action Level	Pb (mg/cm2)	Pb P/F	SITE	Location	SIDE	Color	Component	Substrate
2/18/2025 10:37	55	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	E	White	Window Frame	Wood
2/18/2025 10:38	56	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	E	Brown	Door Frame	Steel
2/18/2025 10:38	57	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	N	White	Ducting	Steel
2/18/2025 10:39	58	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	N	Tan	Wall	Wood
2/18/2025 10:40	59	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	N	Gray	Heater At West End Of N Wall	Steel
2/18/2025 10:40	60	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	N	Gray	Heater At West End Of N Wall	Steel
2/18/2025 10:41	62	Lead Paint (Quick)	1	0.128	Negative	Post Point	Chlor Bldg Interior	Middle Room	Green	Roller Rack Beams On Floor	Steel
2/18/2025 10:41	63	Lead Paint (Quick)	1	0.261	Negative	Post Point	Chlor Bldg Interior	Middle Room	Green	Roller Rack Beams On Floor	Steel
2/18/2025 10:41	61	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	Middle Room	Green	Roller Rack Beams On Floor	Steel
2/18/2025 10:42	64	Lead Paint (Quick)	1	0.105	Negative	Post Point	Chlor Bldg Interior	Middle Room	Green	Roller Rack Beams On Floor	Steel
2/18/2025 10:42	65	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	Middle	Blue	Roller Rack Beams On Floor	Steel
2/18/2025 10:43	68	Lead Paint (Quick)	1	0.451	Negative	Post Point	Chlor Bldg Interior	Middle	Blue	Roller Rack Beams On Floor	Steel
2/18/2025 10:43	66	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	Middle	Blue	Roller Rack Beams On Floor	Steel
2/18/2025 10:43	67	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior	Middle	Blue	Roller Rack Beams On Floor	Steel
2/18/2025 10:45	69	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	W	Tan	Wall	Wood
2/18/2025 10:45	70	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	W	White	Window Frame	Wood
2/18/2025 10:46	72	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	S	Gray	Heater	Steel
2/18/2025 10:46	71	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	S	White	Ducting	Steel
2/18/2025 10:47	74	Lead Paint (Quick)	1	0.307	Negative	Post Point	Chlor Bldg Interior East End	S	Tan	Vertical Pipe	Steel
2/18/2025 10:47	73	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	S	Tan	Vertical Pipe	Steel
2/18/2025 10:48	76	Lead Paint (Quick)	1	0.021	Negative	Post Point	Chlor Bldg Interior East End	S	Tan	Wall	Wiod
2/18/2025 10:48	75	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	S	Tan	Vertical Pipe	Steel
2/18/2025 10:48	77	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	E	Tan	Wall	Wiod
2/18/2025 10:49	78	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	S	Blue Green	4 Inch Capped Pipe	Steel
2/18/2025 10:50	**79**	**Lead Paint (Quick)**	**1**	**1.902**	**Positive**	**Post Point**	**Chlor Bldg Interior East End**	**N**	**Tan And Yellow**	**Wall At EXT 15**	**Wood**
2/18/2025 10:51	81	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	N	Tan	Wall	Wood
2/18/2025 10:51	**80**	**Lead Paint (Quick)**	**1**	**2.045**	**Positive**	**Post Point**	**Chlor Bldg Interior East End**	**N**	**Tan And Yellow**	**Wall At EXT 16**	**Wood**
2/18/2025 10:52	82	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Interior East End	N	White	Window Frame	Wood
2/18/2025 11:09	84	Lead Paint (Quick)	1	0.05	Negative	Post Point	Chlor Bldg Ext	N	Reddish Brown	Wall Between Rock Sections	Wood
2/18/2025 11:09	83	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Ext	N	Reddish Brown	Wall Between Rock Sections	Wood
2/18/2025 11:09	85	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Ext	N	Reddish Brown	Wall Between Rock Sections	Wood
2/18/2025 11:10	86	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Ext	N	Reddish Brown	Door	Wood
2/18/2025 11:11	87	Lead Paint (Quick)	1	0.019	Negative	Post Point	Chlor Bldg Ext	E	Brown	Door	Steel
2/18/2025 11:12	88	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Ext	S	Reddish Brown	Wall	Wood
2/18/2025 11:12	89	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Ext	S	Reddish Brown	Wall	Wood
2/18/2025 11:12	90	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Ext	S	Reddish Brown	Wall	Wood
2/18/2025 11:13	91	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Ext	S	Reddish Brown	Wall	Wood
2/18/2025 11:13	92	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Ext	S	Reddish Brown	Wall	Wood
2/18/2025 11:13	93	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Bldg Ext	W	Reddish Brown	Wall	Wood
2/18/2025 11:29	94	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Ext	W	Reddish Brown	Wall	Wood
2/18/2025 11:29	95	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Ext	S	Reddish Brown	Wall	Wood
2/18/2025 11:33	96	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Ext	E	Reddish Brown	Wall	Wood
2/18/2025 11:33	97	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Ext	N	Reddish Brown	Wall	Wood
2/18/2025 11:33	98	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Ext	N	Reddish Brown	Door	Steel
2/18/2025 11:35	99	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Upper Floor N	White	Wall	Drywall
2/18/2025 11:35	100	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	W	White	Wall	Drywall

Date	Test #	Mode	Action Level	Pb (mg/cm2)	Pb P/F	SITE	Location	SIDE	Color	Component	Substrate
2/18/2025 11:36	101	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	S	White	Wall	Drywall
2/18/2025 11:36	102	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	S	White	Filter	Fiberglass
2/18/2025 11:39	106	Lead Paint (Quick)	1	0.156	Negative	Post Point	Chlor Scrub Bldg Interior	W	Gray	Electrical	Steel
2/18/2025 11:39	103	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	N	Gray	Electrical	Steel
2/18/2025 11:39	104	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	N	Gray	Electrical	Steel
2/18/2025 11:39	105	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	N	Gray	Electrical	Steel
2/18/2025 11:40	107	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	S	Gray	Electrical	Steel
2/18/2025 11:40	108	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	S	Gray	Electrical	Steel
2/18/2025 11:41	109	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Stairs On N	White	Wall	Wood
2/18/2025 11:41	110	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Stairs South	White	Wall	Wood
2/18/2025 11:42	111	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Stairs	Brown	Door	Steel
2/18/2025 11:43	112	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Lower Floor	Gray	Floor	Steel
2/18/2025 11:44	113	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Lower Floor	Light Blue	Pump At Sump	Steel
2/18/2025 11:44	114	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Lowet	Light Blue	Sump Lid At Sump	Steel
2/18/2025 11:45	115	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Lower Floor	Greenish Blue	So Pump	Steel
2/18/2025 11:46	116	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Lower	Light Blue	So Pump	Steel
2/18/2025 11:46	117	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Lower	Light Blue	North Pump	Steel
2/18/2025 11:47	118	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Low	Blue	North Pump	Steel
2/18/2025 11:48	119	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Low	White	NaOH Tank	Steel Or Fiberglass
2/18/2025 11:49	120	Lead Paint (Quick)	1	ND	Negative	Post Point	Chlor Scrub Bldg Interior	Lower At NE Corner	Reddish Brown	Door	Steel
2/18/2025 12:12	121	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Process Drain	Steel
2/18/2025 12:12	122	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Water Plant Effluent	Steel
2/18/2025 12:13	123	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Service Air	Steel
2/18/2025 12:14	124	Lead Paint (Quick)	1	0.001	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Raw Sewage	Steel
2/18/2025 12:14	125	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Raw Sewage	Steel
2/18/2025 12:15	126	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Plant EFF LP	Steel
2/18/2025 12:17	127	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Process Drain (Inside)	Steel
2/18/2025 12:17	128	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Secondary Scum	Steel
2/18/2025 12:18	129	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Secondary Scum	Steel
2/18/2025 12:18	130	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Air Instrumentation	Steel
2/18/2025 12:19	131	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Raw Sewage	Steel
2/18/2025 12:20	132	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Process Drain	Steel
2/18/2025 12:21	133	Lead Paint (Quick)	1	0.001	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Water Plant Eff Lp	Steel
2/18/2025 12:21	134	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Tunnels	Pipe Gallery	Light Blue	Pipe Water Plant Eff Lp	Steel
2/18/2025 12:23	135	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe Water Plant Eff Lp	Steel
2/18/2025 12:23	136	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe Water Plant Eff Lp	Steel
2/18/2025 12:24	137	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe Process Drain	Steel
2/18/2025 12:24	138	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe Primary Sludge	Steel
2/18/2025 12:26	139	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Silver	Pipe Process Drain	Steel
2/18/2025 12:27	142	Lead Paint (Quick)	1	0.011	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe Process Drain	Steel
2/18/2025 12:27	141	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe Process Drain	Steel
2/18/2025 12:27	140	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Silver	Pipe Process Drain	Steel
2/18/2025 12:28	143	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Green	Pump On Primary Sludge	Steel
2/18/2025 12:29	144	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Kight Blue	Pipe Primary Sludge	Steel
2/18/2025 12:31	145	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Gold	Pump Motor Primary Clarifier Dewater	Steel
2/18/2025 12:32	146	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pump Base Primary Clarifier Dewater	Steel

Date	Test #	Mode	Action Level	Pb (mg/cm2)	Pb P/F	SITE	Location	SIDE	Color	Component	Substrate
2/18/2025 12:32	147	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pump Primary Clarifier Dewater	Steel
2/18/2025 12:33	149	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pump Primary Sludge 2	Steel
2/18/2025 12:33	148	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Red	Pump Primary Clarifier Dewater	Steel
2/18/2025 12:34	150	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pump Primary Sludge 2	Steel
2/18/2025 12:34	151	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Red	Pump Primary Scum	Steel
2/18/2025 12:35	152	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Yellow	Pump Primary Scum	Steel
2/18/2025 12:39	153	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe RAS Line	Steel
2/18/2025 12:39	154	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe RAS Line	Steel
2/18/2025 12:39	155	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe RAS Line	Steel
2/18/2025 12:40	156	Lead Paint (Quick)	1	ND	Negative	Post Point	Tunnels Aftet T	Pipe Gallery	Light Blue	Pipe RAS Line	Steel
2/18/2025 12:44	157	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe RAS Line	Steel
2/18/2025 12:44	158	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe RAS Line	Steel
2/18/2025 12:46	161	Lead Paint (Quick)	1	0.071	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe Waste Activated Sludge	Steel
2/18/2025 12:46	159	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe Waste Activated Sludge	Steel
2/18/2025 12:46	160	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe Waste Activated Sludge	Steel
2/18/2025 12:47	162	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe Waste Activated Sludge	Steel
2/18/2025 12:47	163	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe Waste Activated Sludge	Steel
2/18/2025 12:47	164	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe Waste Activated Sludge	Steel
2/18/2025 12:48	165	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Red	Pipe RAS Pump 1	Steel
2/18/2025 12:50	167	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe RAS Pump 2	Steel
2/18/2025 12:50	166	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Red	Pipe RAS Pump 2	Steel
2/18/2025 12:51	168	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe RAS Pump 2	Steel
2/18/2025 12:51	169	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Light Blue	Pipe WAS Pump 2	Steel
2/18/2025 12:52	170	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Blue	Pipe WAS Pump 2	Steel
2/18/2025 12:53	171	Lead Paint (Quick)	1	ND	Negative	Post Point	RAS PUMP ROOM		Blue	Pipe Ras Pump 4	Steel
2/18/2025 13:13	172	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Gallery	Pipe Gallery	Dark Green	W3 Pump 3	Steel
2/18/2025 13:14	174	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Gallery	Pipe Gallery	Dark Green	W3 Pump 2	Steel
2/18/2025 13:14	173	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Gallery	Pipe Gallery	Orange	W3 Pump 2	Steel
2/18/2025 13:15	175	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Gallery	Pipe Gallery	Dark Green	W3 Pump 1	Steel
2/18/2025 13:15	176	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Gallery	Pipe Gallery	Orange	W3 Pump 1	Steel
2/18/2025 13:16	177	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Gallery	Pipe Gallery	Blue	W3 Pump 1 Base	Steel
2/18/2025 13:17	178	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Gallery	Pipe Gallery	Gold	CCB Dewater Pump	Steel
2/18/2025 13:18	179	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Gallery	Pipe Gallery	Light Blue	CCB Dewater Pump	Steel
2/18/2025 13:18	180	Lead Paint (Quick)	1	ND	Negative	Post Point	Pipe Gallery	Pipe Gallery	Light Blue	CCB Dewater Pump	Steel
2/18/2025 13:23	181	Lead Paint (Quick)	1	ND	Negative	Post Point	Pump Pit Near Solids Tank		Light Blue	Process Drain Pipe	Steel
2/18/2025 13:23	182	Lead Paint (Quick)	1	ND	Negative	Post Point	Pump Pit Near Solids Tank		Light Blue	Process Drain Pipe Support	Steel
2/18/2025 13:24	183	Lead Paint (Quick)	1	ND	Negative	Post Point	Pump Pit Near Solids Tank		Light Blue	Process Drain Pipe	Steel
2/18/2025 13:25	184	Lead Paint (Quick)	1	ND	Negative	Post Point	Pump Pit Near Solids Tank		Yellow	Sump Cover	Steel
2/18/2025 13:26	185	Lead Paint (Quick)	1	ND	Negative	Post Point	Pump Pit Near Solids Tank		Red	Pipe	Steel
2/18/2025 13:27	188	Lead Paint (Quick)	1	0.076	Negative	Post Point	Solids Tank		White	Tank	Steel
2/18/2025 13:27	187	Lead Paint (Quick)	1	0.188	Negative	Post Point	Solids Tank		White	Tank	Steel
2/18/2025 13:27	186	Lead Paint (Quick)	1	ND	Negative	Post Point	Solids Tank		White	Tank	Steel
2/18/2025 13:28	189	Lead Paint (Quick)	1	ND	Negative	Post Point	Solids Tank Area		Silver	Tank	Steel
2/18/2025 13:29	**191**	**Lead Paint (Quick)**	**1**	**1.625**	**Positive**	**Post Point**	**Solids Tank Area**		**Yellow**	**EXT Sign On Concrete Post**	**Steel**
2/18/2025 13:29	**190**	**Lead Paint (Quick)**	**1**	**1.732**	**Positive**	**Post Point**	**Solids Tank Area**		**Yellow**	**EXT Sign On Concrete Post**	**Steel**
2/18/2025 13:30	**192**	**Lead Paint (Quick)**	**1**	**2.713**	**Positive**	**Post Point**	**Solids Tank Area**		**Yellow**	**EXT Sign On Concrete Post**	**Steel**

Date	Test #	Mode	Action Level	Pb (mg/cm2)	Pb P/F	SITE	Location	SIDE	Color	Component	Substrate
2/18/2025 13:31	194	Lead Paint (Quick)	1	ND	Negative	Post Point	Solids Tank Area		White	Ductile Iron Pipe	Steel
2/18/2025 13:31	193	Lead Paint (Quick)	1	ND	Negative	Post Point	Solids Tank Area		Yellow	Nat Gas Pipe	Steel
2/18/2025 13:33	195	Lead Paint (Quick)	1	ND	Negative	Post Point	Solids Tank Area		Light Blue	Sump Cover By Sink	Steel
2/18/2025 13:34	196	Lead Paint (Quick)	1	ND	Negative	Post Point	Solids Tank Area		Green	Sink Base	Concrete
2/18/2025 13:50	197	Lead Paint (Quick)	1	1.054	Positive	Post Point	Cal Out		NIST 1.03ppm	Cal Out	Wood
2/18/2025 13:50	198	Lead Paint (Quick)	1	1.066	Positive	Post Point	Cal Out		NIST 1.03ppm	Cal Out	Wood
2/18/2025 13:50	199	Lead Paint (Quick)	1	1.762	Positive	Post Point	Cal Out		NIST 1.03ppm	Cal Out	Wood
2/18/2025 13:51	200	Lead Paint (Quick)	1	ND	Negative	Post Point	Cal Out		NIST Blank	Cal Out	Wood
2/18/2025 13:51	201	Lead Paint (Quick)	1	ND	Negative	Post Point	Cal Out		NIST Blank	Cal Out	Wood
2/18/2025 13:51	202	Lead Paint (Quick)	1	ND	Negative	Post Point	Cal Out		NIST Blank	Cal Out	Wood

March 21, 2025

Mr. Stephen Day
City of Bellingham
210 Lottie St.
Bellingham, WA 98225

Re: Asbestos Containing Material Survey: Roof Cores – Post Point Wastewater Treatment Plant – 200 McKenzie Avenue, Bellingham, WA

Mr. Day:

ALL4 LLC has performed an asbestos containing material (ACM) survey at the Post Point Wastewater Treatment Plant (Facility) located at 200 McKenzie Avenue in Bellingham, Washington (Subject Property).

SCOPE OF WORK

This survey evaluated roofing materials located on the Chlorine Building and the Chlorine Scrubber Building for potential asbestos containing material. The intent of this survey was to comply with the requirement of a "good faith inspection" in conjunction with demolition/redevelopment work being considered at the subject property. The inspection results also provide information to workers that may disrupt suspected materials.

The survey was conducted on March 10, 2024, by Mr. Thomas Davis. Mr. Davis is a registered AHERA Asbestos Building Inspector (Certification#: NES-BIR-20240826-21). The survey was conducted by visually evaluating roofing materials present on the Chlorine Building and the Chlorine Scrubber Building at the Post Point wastewater treatment facility. One roof core from each building was collected at a random location and analyzed for potential ACM.

Potential ACM samples were analyzed using Polarized Light Microscopy by EPA Method 600/R-93/116 at NVL Laboratories in Seattle, Washington. For samples containing more than one layer of material, the laboratory identified each layer individually and provided a total percentage of asbestos contained in each layer.

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ASBESTOS CONTAINING MATERIAL RESULTS

Two bulk asbestos samples were collected. One sample was collected from the roofing materials present on each building. A full profile of the material was collected from the upper surface to the wood or metal base.

ACM was not identified in either of the two roof cores.

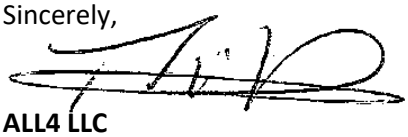
The roof core sample locations are shown in Figure 1. The original Method 600/R-93/116 asbestos analytical data report is included in Appendix A.

CONCLUSIONS

No ACM was identified as part of this survey.

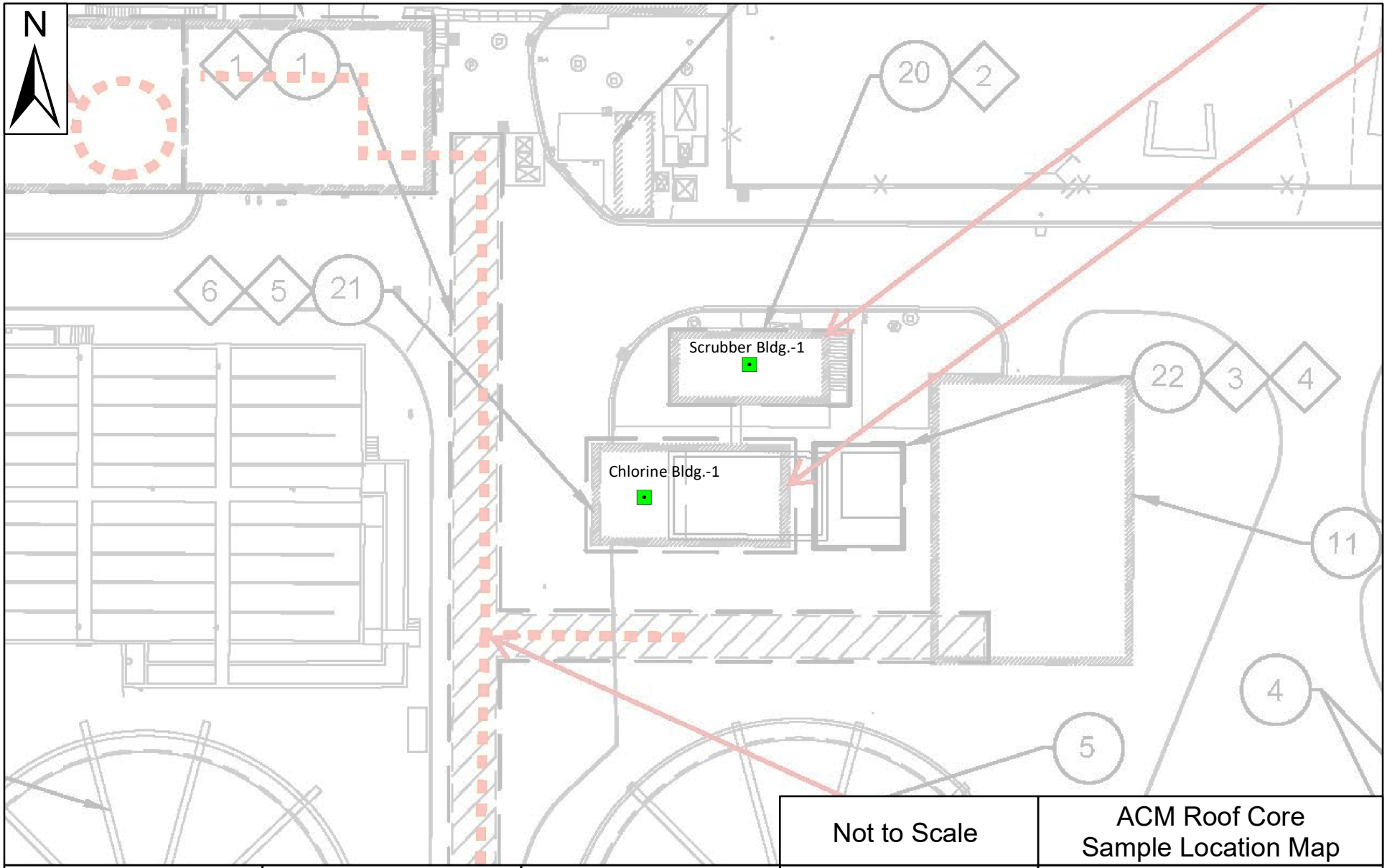
On behalf of ALL4 LLC, I appreciate the opportunity to provide the City of Bellingham with this ACM survey for the Post Point treatment facility in Bellingham, Washington. If you have any questions regarding the report's findings, please call me at (360) 752-9571.

Sincerely,



ALL4 LLC
Thomas Davis, L.G. – Consulting Scientist
AHERA Building Inspector Certification # NES-BIR-20240826-21

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Not to Scale

ACM Roof Core Sample Location Map

ACM Roof Core Samples

Not ACM

All data are approximate and should be used for relative location reference only.

Base Map provided by: The City of Bellingham

Prepared for: CITY OF BELLINGHAM WASHINGTON

Prepared by: ALL4

200 McKenzie Avenue
Bellingham, WA 98225

Post Point ACM/LBP

03/18/2025

Figure 1

APPENDIX A

Asbestos Containing Material Laboratory Analytical Report
(Method EPA 600/R-93/116)

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March 19, 2025

INDUSTRIAL HYGIENE SERVICES
LABORATORY + MANAGEMENT + TRAINING

Thomas Davis
All4 LLC
228 E Champion St #101
Bellingham, WA 98225

RE: Bulk Asbestos Fiber Analysis; NVL Batch # 2504399.00

Client Project: COB Post Point ACM 004529-0002.00
Location: Post Point WWTP, Bellingham, WA

Dear Mr. Davis,

Enclosed please find test results for the 2 sample(s) submitted to our laboratory for analysis on 3/11/2025.

Examination of these samples was conducted for the presence of identifiable asbestos fibers using polarized light microscopy (PLM) with dispersion staining in accordance with **U. S. EPA 40 CFR Appendix E to Subpart E of Part 763**, Interim Method for the Determination of Asbestos in Bulk Insulation Samples and **EPA 600/R-93/116**, Method for the Determination of Asbestos in Bulk Building Materials.

For samples containing more than one separable layer of materials, the report will include findings for each layer (labeled Layer 1 and Layer 2, etc. for each individual layer). The asbestos concentration in the sample is determined by calibrated visual estimation.

For those samples with asbestos concentrations between 1 and 10 percent based on visual estimation, the EPA recommends a procedure known as point counting (NESHAPS, 40 CFR Part 61). Point counting is a statistically more accurate means of quantification for samples with low concentrations of asbestos.

The detection limit for the calibrated visual estimation is <1%, 400 point counts is 0.25% and 1000 point counts is 0.1%

Samples are archived for two weeks following analysis. Samples that are not retrieved by the client are discarded after two weeks.

Thank you for using our laboratory services. Please do not hesitate to call if there is anything further we can assist you with.

Sincerely,

Hilary Crumley, Manager Asbestos Laboratory

NVLAP
Testing
Lab Code: 102063-0

Enc.: Sample Results

Phone: 206 547.0100 | Fax: 206 634.1936 | Toll Free: 1.888.NVL.LABS (685.5227)
4708 Aurora Avenue North | Seattle, WA 98103-6516

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: All4 LLC
Address: 228 E Champion St #101
Bellingham, WA 98225

Attention: **Mr. Thomas Davis**
Project Location: Post Point WWTP, Bellingham, WA

Batch #: 2504399.00
Client Project #: COB Post Point ACM 004529-0002.00
Date Received: 3/11/2025
Samples Received: 2
Samples Analyzed: 2
Method: EPA/600/R-93/116

Lab ID: 250025205 **Client Sample #: Chlorine Bldg.-1**

Location: Post Point WWTP, Bellingham, WA

Comments: Unsure of correct layer sequence.

Layer 1 of 5	**Description:** Crumbly gray rubbery material with fibers			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Rubber/Binder, Fine particles	Polyester	22%	**None Detected ND**
Layer 2 of 5	**Description:** Crumbly gray fibrous material with debris			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Fine particles, Debris	Synthetic fibers	75%	**None Detected ND**
Layer 3 of 5	**Description:** Crumbly white chalky material with paper			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Fine particles, Gypsum/Binder, Fine grains	Cellulose	22%	**None Detected ND**
	Mineral grains			
Layer 4 of 5	**Description:** Crumbly dark gray/black fibrous material			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Binder/Filler, Fine particles	Cellulose	65%	**None Detected ND**
		Glass fibers	7%	
Layer 5 of 5	**Description:** Crumbly light yellow foamy material with adhesive			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Fine particles, Adhesive/Binder, Synthetic foam	None Detected	ND	**None Detected ND**

Lab ID: 250025206 **Client Sample #: Scrubber Bldg.-1**

Location: Post Point WWTP, Bellingham, WA

Layer 1 of 6	**Description:** Black asphaltic fibrous material with granules and debris			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Asphalt/Binder, Asphaltic Particles, Granules	Synthetic fibers	55%	**None Detected ND**

Sampled by: Client
Analyzed by: Muhammad Yousuf **Date:** 03/17/2025
Reviewed by: Hilary Crumley **Date:** 03/19/2025

Hilary Crumley, Manager Asbestos Laboratory

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and EPA 40 CFR Appendix E to Subpart E of Part 763 with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: All4 LLC
Address: 228 E Champion St #101
Bellingham, WA 98225

Attention: **Mr. Thomas Davis**
Project Location: Post Point WWTP, Bellingham, WA

Batch #: 2504399.00
Client Project #: COB Post Point ACM 004529-0002.00
Date Received: 3/11/2025
Samples Received: 2
Samples Analyzed: 2
Method: EPA/600/R-93/116

	Fine grains, Debris	Cellulose	4%	
Layer 2 of 6	**Description:** Black asphaltic fibrous material with debris			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Asphalt/Binder, Asphaltic Particles, Debris	Glass fibers	57%	**None Detected ND**
	Plastic	Cellulose	3%	
Layer 3 of 6	**Description:** Black asphaltic fibrous material with granules and debris			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Asphalt/Binder, Asphaltic Particles, Granules	Synthetic fibers	53%	**None Detected ND**
	Fine grains	Cellulose	7%	
Layer 4 of 6	**Description:** Black asphaltic fibrous material with debris			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Asphalt/Binder, Asphaltic Particles	Glass fibers	55%	**None Detected ND**
		Cellulose	5%	
Layer 5 of 6	**Description:** Crumbly brown fibrous material with asphalt			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Binder/Filler, Asphaltic Particles, Perlite	Cellulose	72%	**None Detected ND**
Layer 6 of 6	**Description:** Crumbly white soft material			
	Non-Fibrous Materials:	Other Fibrous Materials:	%	**Asbestos Type: %**
	Binder/Filler, Fine particles, Styrofoam	None Detected	ND	**None Detected ND**

Sampled by: Client
Analyzed by: Muhammad Yousuf **Date:** 03/17/2025
Reviewed by: Hilary Crumley **Date:** 03/19/2025

Hilary Crumley, Manager Asbestos Laboratory

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and EPA 40 CFR Appendix E to Subpart E of Part 763 with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government

ASBESTOS LABORATORY SERVICES

Company	All4 LLC	**NVL Batch Number**	**2504399.00**
Address	228 E Champion St #101 Bellingham, WA 98225	**TAT** 5 Days **AH** No **Rush TAT**	
Project Manager	Mr. Thomas Davis	**Due Date** 3/18/2025 **Time** 9:50 AM	
Phone	(360) 752-9571	**Email**	tdavis@all4inc.com
Cell	(253) 906-6648	**Fax**	(360) 752-9573

Project Name/Number: COB Post Point ACM 004529 **Project Location:** Post Point WWTP, Bellingham, WA

Subcategory PLM Bulk

Item Code ASB-02 EPA 600/R-93-116 Asbestos by PLM <bulk>

Total Number of Samples 2 Rush Samples

	Lab ID	Sample ID	Description	A/R
1	250025205	Chlorine Bldg.-1		A
2	250025206	Scrubber Bldg.-1		A

	Print Name	Signature	Company	Date	Time
Sampled by	Client				
Relinquished by	UPS				

Office Use Only	Print Name	Signature	Company	Date	Time
Received by	Laura Carcone		NVL	3/11/25	0950
Analyzed by	Muhammad Yousuf		NVL	3/17/25	
Results Called by					
☐ **Faxed** ☐ **Emailed**					

Special Instructions:

Date: 3/11/2025
Time: 10:32 AM
Entered By: Laura Carcone

NVL
INDUSTRIAL HYGIENE SERVICES
LABORATORY + MANAGEMENT + TRAINING

2504399

A CHAIN OF CUSTODY

Turn Around Time

❑ 1 Hour	❑ 24 Hours	❑ 4 Days
❑ 2 Hours	❑ 2 Days	☒ 5 Days
❑ 4 Hours	❑ 3 Days	❑ 10 Days

Please call for TAT less than 24 Hours

Company ALL4 Inc.
Address 228 East Champion Street, Suite #101
Bellingham, WA 98225
Phone (360) 752-9571

Project Manager Thom Davis
Cell (253) 906 - 6648
Email tdavis@all4inc.com
Fax ( ) -

Project Name/Number COB: Post Point ACM 004529-0002.00
Project Location Post Point WWTP Bellingham, WA

- ❑ PCM Air (NIOSH 7400)
- ☒ PLM (EPA 600/R-93-116)
- ❑ PLM Gravimetry (600/R-93-116)
- ❑ Asbestos Friable/Non-Friable (EPA 600/R-93/116)
- ❑ TEM (NIOSH 7402)
- ❑ EPA 400 Points (600/R-93-116)
- ❑ Asbestos in Vermiculite (EPA 600/R-04/004)
- ❑ TEM (AHERA)
- ❑ Other
- ❑ TEM (EPA Level II Modified)
- ❑ EPA 1000Points (600/R-93-116)
- ❑ Asbestos in Sediment (EPA 1900 Points)

Reporting Instructions
❑ Call ( ) - ❑ Fax ( ) - ☒ Email

Total Number of Samples 13

	Sample ID	Description	A/R
1	Chlorine Bldg.-1		
2	Scrubber Bldg.-1		
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

	Print Name	Signature	Company	Date	Time
Sampled by	Thom Davis		ALL4	March 10, 2025	1215
Relinquish by					

Office Use Only

	Print Name	Signature	Company	Date	Time
Received by	LAUREA C		NVL	3/11/25	0950LPS
Analyzed by					
Called by					
Faxed/Email by					

APPENDIX B.10:
POST POINT INDUSTRIAL STORMWATER GENERAL PERMIT
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

The Post Point Resource Recovery Plant operates under the authorization of coverage per the State of Washington Department of Ecology Industrial Stormwater General Permit (WAR005561). All work occurring on the Post Point Recovery Plant site must comply with this permit and other applicable stormwater regulations as required.

A copy of the full Industrial Stormwater General Permit (ISGP) is available at the Ecology webpage for the ISGP:
https://ecology.wa.gov/regulations-permits/permits-certifications/stormwater-general-permits/industrial-stormwater-permit

The current ISGP is hereby incorporated by reference into this contract.

The Contractor shall review the ISGP, coverage letter, Stormwater Pollution Prevention Plan for Post Point, and the Project Special Provisions in development of a Stormwater Pollution Prevention Plan for this project. The Contractor shall be responsible for limiting any discharges of construction or process related fluid products such as plant influent, wastewater, solids and any stormwater or runoff related to the project during the course of the work. Immediate spill response and cleanup of any discharge related to the work of this contract shall be the Contractor's responsibility.

In addition to the above requirements, the contractor shall coordinate with the City Project Manager and arrange for personnel working at the project site to complete training on the requirements of the ISGP for this site. Training shall be completed and signed off for all on-site personnel. Reference the "Stormwater Requirements at Post Point Treatment Plant" document found in this Appendix.

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

PO Box 47600, Olympia, WA 98504-7600 • 360-407-6000

December 3, 2024

Kim Lund
City of Bellingham
210 Lottie St
Bellingham, WA 98225

WAR005561
Post Point Wastewater Treatment Plant
200 MCKENZIE AVE
BELLINGHAM, WA 98225

RE: Coverage under the Industrial Stormwater General Permit: WAR005561

Dear Kim Lund:

On December 2, 2024, the Washington State Department of Ecology (Ecology) reissued the Industrial Stormwater National Pollutant Discharge Elimination System and State Waste Discharge General Permit (ISGP). The permit becomes effective on January 1, 2025, and expires December 31, 2029. This is your permit coverage letter for Permit Number WAR005561, effective January 1, 2025. Retain this letter with a copy of the permit and Stormwater Pollution Prevention Plan (SWPPP). It is the official record of permit coverage for your site. For easy access from your site, you may keep your records in an accessible electronic format.

Permit Overview

The new ISGP has a number of changes. The changes are summarized in the fact sheet and Appendix C Addendum to Fact Sheet. You can find copies of the new Industrial Stormwater General Permit, permit forms, and other information at ecology.wa.gov/IndustrialStormwaterPermit.

Discharge Monitoring Reports and Site-Specific Monitoring Requirements

The ISGP requires you to submit quarterly discharge monitoring reports (DMRs) electronically using Ecology's secure online system, WQWebDMR. Find step-by-step instructions on how to register for WQWebDMR and the WQWebDMR User Guide at ecology.wa.gov/programs/wq/permits/paris/webdmr.html If you have questions about using WQWebDMR, contact the Water Quality Information Technology Help Desk at 360-407-7097 or email WQWebPortal@ecy.wa.gov.

We are currently updating our Permit and Reporting Information System (PARIS) database with the site-specific monitoring requirements of the new ISGP, based on the renewal application you submitted earlier this year. We will send you an additional site-specific monitoring summary page with more information after we have finished setting up your monitoring requirements and DMRs in the PARIS database. We will send you this monitoring summary page as soon as possible to support your collection of samples and submitting the first DMR of the permit cycle, due on May 15, 2025.

Permit Fees

State law (RCW 90.48.465) requires that all permittees pay an annual permit fee based upon the state fiscal year. The state fiscal year begins each year on July1 and ends on June 30 the following year. Ecology sends permit fee invoices to all permittees annually. Permittees who have permit coverage on or after July 1 will receive a permit fee invoice for coverage during that state fiscal year. If you would like more information on the permit fee process, visit Ecology's Water Quality Permit Fees webpage (ecology.wa.gov/WQFees) or email the Fee Unit at wqfeeunit@ecy.wa.gov.

Your Right to Appeal

You have a right to appeal the final general permit and general permit coverage for a specific facility to the Pollution Control Hearings Board. Appeals of general permit coverage must be filed within 30 days of the receipt of this coverage letter, where "date of receipt" is defined in RCW 43.21B.001(2). Any appeal is limited to the general permit's applicability or non-applicability to a specific discharger.

The appeal process is governed by chapter 43.21B RCW and chapter 371-08 WAC. For more information regarding your right to appeal, view Appeal of a General Permit Coverage, apps.ecology.wa.gov/publications/SummaryPages/1710007.html.

Permit Administration Assistance

If you have questions regarding your application, updating permit information, finding or completing permit forms, permit transfers or termination, or drafting public notices please contact your permit administrator Melinda Wilson, MEWI461@ecy.wa.gov, (360) 870-8290.

Ecology Regional Inspector Assistance

If you have questions regarding stormwater management issues at your facility, please contact your regional inspector Jen Baptist, jbap461@ecy.wa.gov, (564) 565-0327.

Questions or Additional Information
Ecology is here to help. Please review our permit webpage at ecology.wa.gov/IndustrialStormwaterPermit. If you have any questions about the interpretation or implementation of the new ISGP, please contact Shannon McClellan, Shannon.McClellan@ecy.wa.gov, 360-280-8370.

Sincerely,



Jeff Killelea, Manager
Permit and Technical Services Section
Water Quality Program

Stormwater Pollution Prevention Plan (SWPPP)

for

Post Point Wastewater Treatment Plant

Rev. 15, 04/23/25

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GENERAL FACILITY INFORMATION

Name of Facility:	Post Point Wastewater Treatment Plant
Facility Address:	200 McKenzie St Bellingham, WA 98225
Location:	48.718 N, 122.514 W (WKID 4326)
Facility Contact:	
Name:	Yohann Misquitta
Title:	Operations Supervisor
Telephone:	(360) 778-7850
After Hours:	(360) 778-7855
Mailing Address:	2221 Pacific Street Bellingham, WA 98229
Owner:	City of Bellingham
Standard Industrial Classification (SIC) Code:	9511
Receiving Water Body ID:	Bellingham Bay (Outer)
Discharge Point:	48.7197 N, 122.5236 W (WKID 4326)
Permit Information:	
Type:	General
Permit Number:	WAR005561
Effective Date of Coverage:	January 1, 2025
Emergency Contacts:	
Steve Bradshaw Superintendent of Operations	(360) 778-7700
Peg Wendling Technical Supervisor	(360) 778-7870

1.0 Overview

1.1 Introduction

This Stormwater Pollution Prevention Plan (SWPPP) covers the operations at the City of Bellingham Post Point Wastewater Treatment Plant. It has been developed as required under section S3 of the Industrial Stormwater General Permit. The Industrial Stormwater General Permit is issued by the State of Washington Department of Ecology in compliance with the provisions of the State of Washington Water Pollution Control Law Chapter 90.48 Revised Code of Washington and the Federal Water Pollution Control Act (the Clean Water Act) Title 33 United States Code, Section 1251 et seq.

The General Permit is a National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for Stormwater Discharges Associated with Industrial Activities. Relevant dates include Issuance Date: December 2, 2024, Effective Date: January 1, 2025 and Expiration Date: December 31, 2029.

The SWPPP describes this facility and its operations. It identifies potential sources of stormwater pollution at the facility and recommends appropriate best management practices (BMPs) or pollution control measures to reduce the discharge of pollutants in stormwater runoff. There is a provision for periodic review of the SWPPP.

1.2 Objectives

The primary goal of the stormwater permit program is to improve the quality of surface waters by reducing the amount of pollutants potentially contained in the stormwater runoff being discharged to surface waters. Industrial facilities subject to a NPDES permit must prepare and implement a SWPPP for their facility.

The objectives of this SWPPP are to:

1. Identify potential sources of stormwater and non-stormwater contamination to the stormwater drainage system at the Post Point Pollution Control Plant.

2. Implement and maintain BMPs to identify, reduce, eliminate, and/or prevent the discharge of stormwater pollutants.

3. Prevent violations of surface water quality, ground water quality, or sediment management standards.

4. Prevent impacts to receiving waters by controlling peak rates and volumes of stormwater runoff.

5. Provide other elements such as, but not limited to, a facility inspection program, site compliance evaluation program, record keeping and reporting program that will help the Post Point Pollution Control Plant comply with the terms and conditions of their stormwater discharge permit.

2.0 Stormwater Pollution Prevention Team

The stormwater pollution prevention team is responsible for developing, implementing, maintaining, and revising this SWPPP. The members of the team are familiar with the management and operations of the Post Point Pollution Control Plant.

The members of the team and their primary responsibilities are as follows:

Title	Responsibility
Chief Operator	Scheduling and conducting good housekeeping at the site, maintaining operational BMPs, reporting and responding to spills at treatment plant
Technical Supervisor	Ensuring that sampling, laboratory analysis and reporting is conducted per the requirements and the SWPPP
Water Quality Specialist and Laboratory Analyst	SWPPP updates, sampling and monitoring, conducting inspections, tracking, follow up, data handling and reporting, organizing and documenting employee training
Maintenance	Assistance and technical support for preventive maintenance activities

3.0 Potential Sources of Stormwater Pollution

3.1 Facility Description

The Post Point Wastewater Treatment Plant is a wastewater treatment plant for the City of Bellingham. All work is performed indoors except maintenance of building exteriors. The amount of plant influent is dictated in large part by the seasons. The hydraulic load increases with the winter rainy season and decreases in the drier summer months. Buildings that house support services include the Emergency Power Building, Maintenance Shop, Storage Building, Administrative Offices, and Laboratory.

Septic tank waste and wastewater from over 300 miles of sewer collection mains in Bellingham and the surrounding community enter the plant through the Screenings Facility. The wastewater is pre-chlorinated and aerated to control bacteria and reduce odors. Materials that can harm or plug plant processes, such as rocks, rags, and other large debris are removed. These objects are de-watered, compressed, placed in a dumpster, and sent to a landfill.

The wastewater then enters the Grit Removal Building. The water flows into a grit chamber where it slows down to allow sand and other heavy particles to settled out before flowing to two covered primary clarifiers. In the approximately two hours the water remains in the primary clarifiers, suspended solids (primary sludge) settle to the bottom and oil and grease (scum) rises to the surface where they are skimmed off and sent to the Solids Handling Building for disposal.

The wastewater flows into large, enclosed Aeration Basins where it is mixed with activated sludge (microorganisms) and aerated. Microorganisms in the activated sludge trap and remove contaminants. The water then flows into four covered secondary clarifiers. Activated sludge settles

to the bottom of the clarifiers. Some activated sludge is returned to the Aeration Basins via the Secondary Sludge Pump Station. The remainder is sent to Solids Handling.

Wastewater is chlorinated as it leaves the Secondary Clarifiers. Sodium hypochlorite used in this process is generated onsite in the dedicated sodium hypochlorite building. Wastewater enters the Chlorine Contact Chamber following the application of chlorine to kill any remaining pathogenic organisms. The effluent is dechlorinated using sodium bisulfite before entering an outfall on the west side of the plant, which flows to a discharge point in Bellingham Bay. During periods of hydraulic loading greater than plant capacity, excess effluent is discharged via the alternate outfall which also discharges to Bellingham Bay.

In Solids Handling primary and secondary solids are placed on a gravity belt where polymer is added to thicken the sludge. A centrifuge then removes excess water from the sludge. The sludge is incinerated in two multiple-hearth gas-fired incinerators heated to 1500°F. This reduces the volume by approximately 75% and destroys pathogens. Waste gases pass through an afterburner, two wet scrubbers and an electrostatic precipitator to reduce emissions. Odors associated with sewage are removed in the Solids Handling Building and the Odor Scrubber Building. Sodium hypochlorite and activated carbon are used in this process.

3.2 Site Maps

Site Map 1 presents a site map of the facility showing the following features:
- Site size, scale and boundaries
- The location and extent of all buildings, structures and impervious surfaces
- Dumpsters and recycle holding areas
- Areas of pollutant contact (actual or potential)
- Locations where the following activities are exposed to stormwater:
    -loading/unloading areas
    -liquid storage tanks

Site Map 2 presents a site map of the facility showing the following features:
- Stormwater conveyance system
- Outline of the stormwater drainage areas for each discharge point
- Location of monitoring point
- Locations of structural source control BMPs
- Location of combined MS4 system flowing onsite
- Location of discharge point and location of nearest receiving water

Site Map 3 presents a site map of the facility showing the following features:
- Direction of stormwater flow

Site Map 4 presents a site map of the facility showing the following features:
- Process Flow

3.3 Industrial Activities Inventory

Inventory of Industrial Activities	
Activity	**Description**
Unloading chemicals	Unloading areas have a very low potential to contaminate stormwater because of containment area practices. All chemicals except diesel fuel are located inside buildings, within containment areas with sumps. An operator stands by with spill kit each time a truck unloads chemicals. Sewage trucks are unloaded inside a fully enclosed dumping bay.
Air emissions and ash generating activities	Incineration of primary and secondary sludge generates some dust and particulates that have the potential to be deposited on roof tops and other surfaces, especially when ash from the incinerators is moved to a trailer for transport offsite. The ash trailer is located in a covered loading area and containment curtains are installed at the front and back of the loading area to reduce wind effects and fugitive dust. There is a procedure for ash handling to minimize fugitive emissions, and ash is wetted at the time of transfer to reduce chances to become airborne, however, ash has the potential to be released, eventually washing into the stormwater.
On-site waste disposal	Grit loading areas could potentially contaminate stormwater. The nearby stormwater drain has been equipped with a sediment, oil and grease insert to mitigate impacts if this occurs.
Other	Incidental potential sources of stormwater contamination include materials from tire wear and fluid leaks from delivery trucks and septage haulers.

3.4 Inventory of Potential Sources

The SWPPP requires a list of significant spills and leaks of toxic or hazardous pollutants since November 18, 1989. There have been no significant spills or leaks of toxic or potentially hazardous pollutants at the Post Point Pollution Control Plant since November 18, 1989.

The Material Inventory is a list of materials handled, treated, or disposed of at the Post Point Pollution Control Plant that may be exposed to precipitation or runoff. The materials listed (except ash) could only be present in stormwater in the unlikely event of a diesel containment breach, leakage from delivery trucks, or a hose burst during offloading. Bellingham practices self-generation of hypochlorite from salt. Salt used for the generation of hypochlorite will be stored inside.

This portion of the SWPP will be updated as the presence/absence of these pollutants in stormwater are verified through quarterly and annual monitoring.

Material Inventory								
Material	**Location on Site Map (Figure 1)**	**Quantity (Units)**			**Exposed Since Nov. 89 (Yes/No)**	**Likelihood of Contact with Stormwater**	**Past Leak or Spill**	
		Used	**Produced**	**Storage capacity**			**Yes**	**No**
		(Indicate per day, week, or year)						
Sodium Chloride (Salt)	sodium hypochlorite generation	Usage varies based on demand		90,000 lbs	No	Unlikely		√
Diesel Fuel	diesel fuel tank	Usage varies based on power outages		4,000 gal	No	Unlikely		√
Sodium Bisulfite 39%	sodium bisulfite unloading	10 - 20 gal per day		4,800 gal	No	Unlikely		√
Sodium Hydroxide 20%	sodium hydroxide unloading	Standby status for neutralizing chlorine gas		2200 gal	No	Unlikely		√
Sodium Hypochlorite 12%	sodium hypochlorite unloading	41 gal per day		3,000 gal	No	Unlikely		√
Ash Particulate	ash loading		33 cu yds per week	42 cu yds	No	Possible		√

3.5 Materials Storage and Handling

- Sodium chloride

Sodium chloride salt is brought on-site in bulk trailers and off-loaded into two 45,000 gallon tanks where it is mixed with water and converted to 1% Sodium hypochlorite solution. Sodium hypochlorite solution is pumped through the plant tunnels to the various application points.

- Diesel fuel

Diesel fuel is brought on-site in bulk trailers and off-loaded into a 4,000-gallon steel tank located in a containment area on the northeast corner of the plant site next to the Emergency Power Building. Diesel is automatically called for and pumped to the adjacent Emergency Power Building during a plant power outage.

- Sodium bisulfite

Sodium bisulfite is brought on-site in bulk trailers and off-loaded into two 2,400-gallon fiberglass tanks located in a containment area in the Bisulfite Storage Room. Sodium bisulfite is pumped through the plant tunnels to the point of application in the chlorine contact chambers. Pumps start and stop automatically.

- Sodium hydroxide

Sodium hydroxide is brought on-site in bulk trailers and off-loaded at the Chlorine Storage Building into a 2,500-gallon fiberglass tank. The basement of the building is the containment area. Sodium hydroxide is recycled using a pump within the Emergency Scrubber Building.

- Sodium hypochlorite

Sodium hypochlorite (12%) is brought on-site in bulk trailers and off-loaded at the Odor Scrubber Building into a 3,000-gallon fiberglass tank within a containment. Sodium hypochlorite is pumped to the air scrubbers in the Odor Scrubber Building and through the plant tunnels to the scrubber in the Solids Handling Building.

4.0 Other Plans Incorporated

Emergency Response and Spill Control Plans

The Post Point Pollution Control Plant has Emergency Response and Spill Control Plans in operation for hazardous materials stored on-site. These plans are kept in the Operations Control Room. A copy of the Spill Control Plan also accompanies this SWPPP. Overlaps are noted below:

- The Operations Supervisor is one of the Emergency Response Coordinators. She will also be the Stormwater Spill Prevention and Response Coordinator.
- List of hazardous chemicals, quantities, locations and containment.
- Spill prevention and spill response procedures.
- Relevant portions of the Emergency Response and Spill Control Plans are adopted by reference.

Laboratory Quality Assurance Manual

The Post Point Pollution Control Plant has a Laboratory Quality Assurance Manual. Overlaps are noted below:

- Procedures for sample handling.
- Procedures for sending samples to outside laboratories.
- Relevant portions of the Laboratory Quality Assurance Manual are adopted by reference.

5.0 Monitoring Plan

The purpose of the monitoring plan is to evaluate stormwater outfalls for the presence of non-stormwater discharges and to evaluate the effectiveness of the plant's pollution prevention activities in controlling contamination of stormwater discharges. Monitoring includes site inspections as well as the collection and analysis of stormwater samples.

5.1 Point of Discharge

As of June 2014, there is only one discharge point for stormwater from the Post Point Wastewater Treatment Plant. Stormwater is discharged from the parking lot on the north boundary of the treatment plant into the pipeline known as the alternate outfall at point B (figure 3). The alternate outfall ultimately discharges to Bellingham Bay at 48.7197 N, -122.5236 W. Visual inspections will be performed at point B.

Samples for discharge point B will be collected from catch basin PPB2 (Figure 2). Catch basin PPB2 conveys stormwater from the areas with the greatest potential to contain pollutants - the diesel fuel tank and unloading area and the sodium hypochlorite unloading area. Discharge point B was not chosen for sample collection because connections from the stormwater conveyance systems of adjacent businesses occur at two points prior to discharge point B. Due to these inputs, the discharge at point B is not considered representative of facility stormwater. The drainage area omitted from the sampling mainly consists of two small parking lots and does not include any of the wastewater process areas. The drains in both parking lots have been equipped with drain inserts for sediment, oil and grease removal.

The estimation of volume/rate of discharge for discharge point B is problematic. Inflow pipes to catch basins are at least partially submerged during storm events and access is limited. Flows for each discharge point will be estimated based on area, amount of rainfall, and pipe diameter and run.

The chemicals listed in the inventory (Section 3.4) could only be present in stormwater as a result of a catastrophic event (i.e. spill or hose rupture). Because ash particulates from the ash loading area have the potential to come in contact with stormwater, both drains in that area have been equipped with drain inserts for sediments as well as oil and grease. Incidental sources such as materials from tire wear and truck fluid leaks are not expected to be present in measurable amounts. Should it become apparent that incidental sources are impacting stormwater, controls will be modified as necessary.

5.2 Sampling

1. Stormwater Sampling

Stormwater sampling shall be conducted on a quarterly basis, including every attempt to sample during the first qualifying storm event after September 1st. Quarters are defined as:

First Quarter:	January, February, March
Second Quarter:	April, May, June
Third Quarter:	July, August, September
Fourth Quarter:	October, November, December

Laboratory personnel will conduct stormwater sampling. Samples will be collected by grab or time-proportionate method. Grab samples will be collected in sample bottles provided by a laboratory accredited in the method(s) used. Sampling will occur within the first twelve hours of stormwater discharge, or as soon as practicable. Every effort will be made to sample within the first 30 minutes of stormwater discharge. Documentation of when and why sampling occurred will be kept with the SWPPP.

Samples will be kept refrigerated at or below 6°C prior to analysis. Samples will be analyzed for pH, turbidity, copper and zinc as quickly as is reasonably possible. Post Point Laboratory (ECY# W669) personnel will perform pH and turbidity analysis. A laboratory with accreditation recognized by the state will perform analysis for copper and zinc using EPA Method 200.8. Samples for copper and zinc will be preserved with HNO_3 following collection. Samples will be transported to the laboratory as soon as possible to meet holding time requirements.

Sample chain of custody information for turbidity and pH is compiled on the laboratory benchsheet corresponding to the sample analysis. For copper and zinc, a chain of custody form will accompany samples and a copy retained at the Post Point Laboratory. Information recorded includes sample location, time and date of collection, time and date of analysis and sampler/analyst.

The Technical Supervisor is the sample custodian. The Technical Supervisor also ensures proper sample storage, laboratory entry only to authorized personnel, and has responsibility of laboratory security when authorized personnel are not present. The Post Point laboratory has a designated sample receiving room, the main access of which is in a restricted portion of the plant

If eight consecutive quarters of sampling result in consistent attainment of the benchmark values listed in the Industrial Stormwater General Permit, quarterly sampling and analysis may be suspended and annual sampling during the 4th quarter conducted in its stead.

2. Sampling Location

There is currently one sampling location (PPB2) included in the SWPPP monitoring plan (figure 3). It is marked B, with yellow spray paint for ease of identification.

Sampling discharge point PPB2:

Samples for site B are taken from the round catch-basin located to the northwest of the former chlorine storage building (no longer in use). Lift the storm drain lid using ergonomic grate-puller. Fill bottles from the water stream coming in from the Northeast. Replace lid.

Sampling Kit

A sampling kit is located in the blue cooler on the shelves in the Water Quality Specialist office. The sampling kit should contain these instructions, Wet Season Visual Observation Forms for the site, and the following sample bottles:

Parameter	**Sample Bottles**
Zinc	1 250 ml polyethylene
Turbidity, pH	1 500 ml polypropylene

Also take the following items with you when you go out in the plant to sample:

1. Ice packs, cooler, towels
2. Disposable gloves for clean sampling.
3. Telescoping rod.
4. Grate puller for removing storm drain lid.
5. Plastic bottle clasps for securing bottles (also in sampling kit).

Generic Clean Sampling Note:

Bottles must NOT be filled near gasoline cans, gasoline powered motors, paint cans, lighter fluid, paint strippers, pesticide bottles, or exhaust fumes from running engines. Do not fuel up vehicles prior to sampling. Fumes and vapors may contaminate the samples. Wash hands and do not handle coins prior to sampling. Be careful not to touch or otherwise contaminate the inside of the lid of the bottle during sampling. Do not allow the lip of the bottle to touch any debris (i.e. dust on grate rim) during sampling. All samples need to be kept cold.

Sample Collection:

1. Freeze ice packs before collecting samples.

2. Check for rain. In order to sample, the rainfall should be an event of 0.1 inches or more and discharging to the bay. Stormwater should be sampled within 12 hours of the onset of discharge. Every effort should be made to sample within 30 minutes of onset of discharge. Do not sample during adverse or dangerous climatic conditions such as flooding, high winds, electrical storms, etc.
3. Put pertinent information (i.e. location, city identification) on each sampling container.
4. Fill all sample containers from each source at the same time and under the same conditions in order to maintain representative and consistent sampling. Avoid agitation of the sample while filling. Do not rinse or overfill the bottles. It is important to avoid collection of solid materials over 1/2 inch in diameter. In most cases these materials are not representative of the stormwater discharge.
5. After filling, carefully cap each sampling container and complete label on each sampling container with pertinent chain of custody information (time, date, and sampler initial).
6. Within 15 minutes of collection proceed with pH and turbidity analysis. Use lab bench sheet designated for these analyses and record all chain of custody information there.
7. Upon returning to the lab, preserve the sample taken for zinc and copper using 1 ml of reagent grade HNO_3.
8. Fill out Chain-of-Custody information on form provided with the sample kit. This needs to be completed for zinc and copper analysis. Remember to initial and sign the form in the spaces provided and to specify zinc and copper analysis per EPA Method 200.8.
9. Arrange for the drop-off or lab courier pick up of the samples. Specify sample pick-up within 24-hours. Load ice packs and bottles in cooler with enough packing material to make closing the lid difficult. Assume the shipping people toss sample coolers into their trucks.
10. If a contract lab courier is unavailable in this time frame, instruct the warehouse to ship the cooler overnight delivery. All overnight deliveries must be to warehouse no later than 1:00 pm.
11. Save a copy of the chain of custody form in the lab three ring binder labeled "Outside Lab Chain of Custody Forms".
12. Be sure a new sample kit arrives before the next scheduled sampling period, if not call Edge.

Ensure any results received have been reviewed by Lab Supervisor prior to being filed.

5.3 Inspections

The Water Quality Specialist will be responsible for site inspections. Visual inspections shall be conducted on a monthly basis, and in response to benchmark exceedances. Monthly inspections will include inspection of the impervious surfaces, facility processes, vehicles, equipment and the stormwater conveyance system. Inspection shall include observations of discharges to ground and for the presence of floating materials, visible sheen, discoloration, turbidity, odor, etc. in the stormwater discharge.

Inspections shall assess the SWPPP BMPs required by this permit. The inspection will be used to verify that the description of potential pollutant sources required under this permit is accurate, the site map as required by the SWPPP has been updated or otherwise modified to reflect current conditions, and the BMP controls to reduce pollutants in stormwater discharges associated with industrial activity identified in this SWPPP are implemented, properly maintained and effective.

5.4 Compliance Testing

Analytical Methodology: Standard Methods for the Examination of Water and Wastewater 23rd Edition (2017): zinc: SM 3500-Zn (EPA 200.8), copper: SM 3500-Cu (EPA 200.8), pH: SM 4500-H+, turbidity: SM 2130 B (EPA 180.1).

Suggested Accredited Testing Laboratories:

Edge Analytical Testing
1151 Knudson Road
Burlington, WA 98233
Tel: 1-800-755-9295

Exact Scientific
1355 Pacific Place #101
Ferndale, WA 98248
(360) 733-1205

***** Most contract labs do not accept samples weekends

6.0 Best Management Practices

Stormwater management controls, or best management practices (BMPs), have been or will be implemented to reduce the amount of or eliminate pollutants in stormwater discharged from the Post Point Wastewater Treatment Plant. The BMPs described here are in accordance with the BMPs described by the Washington State Department of Ecology in the 2019 Stormwater Management Manual for sites west of the crest of the Cascade Mountains.

6.1 Operational Source Control BMPs

- **Good Housekeeping**
  The Operations Supervisor is responsible for overseeing the good housekeeping program. Good housekeeping practices are designed to maintain a clean and orderly work environment. This will reduce the potential for significant materials to come in contact with stormwater.

  The following practices are included in our good housekeeping routine:

Good Housekeeping BMPs	
BMP	**Frequency**
Contain and clean up solid and liquid pollutant leaks and spills including oils, solvents, fuels, and dust on any exposed soil, vegetation, or paved area.	As needed.
Sweep/Vacuum paved areas for collection and disposal of dust and debris that could contaminate stormwater.	Monthly as weather permits. Quarterly at a minimum.
Regularly inspect, sweep and vacuum ash accumulation areas that can contaminate stormwater (Including CBs).	Weekly as weather permits.
Clean roof tops.	Quarterly
Clean oils, debris, sludge, etc from all BMP systems.	Catch basins – quarterly. All others - as needed.

Drain inserts to control sediments, oil and grease are in place in parking lot drains, grit loading area drain, and incinerator ash loading area drains.	At all times.
Drain inserts checked and replaced.	Checked Quarterly. Replaced as needed.
Repair or replace all substantially cracked or damaged paved secondary containment, parking, and any other drainage areas, which may be subjected to pollutant material leaks or spills.	As needed.
Repair or replace all leaking connections, pipes, hoses, valves, etc that can contaminate stormwater.	As needed.
Use solid absorbents for cleanup of liquid spills/leaks.	Where practicable.
Recycle materials such as oils and solvents.	To the maximum extent practicable.
Employees are trained and follow SOP to handle ash carefully to prevent airborne ash that could eventually contaminate stormwater - ash is wetted with water before loading into waste containers.	Daily.
Good Housekeeping BMPs	
BMP	**Frequency**
Ash filtration/collection systems are used to control ash emissions.	At all times.
Additional spray heads/larger nozzles installed to further wet ash prior to loading in container.	At all times.
Plastic curtains installed around ash loading chute.	At all times.
Citywide policy dictates pesticide use. Includes using pesticides as a last resort, choosing least toxic pesticides, and pesticide use plan.	As necessary.
Use manual methods of vegetation removal rather than applying herbicides.	When possible.
Pesticides are applied according to label instructions.	At all times.
Pesticides are mixed in an area where accidental spills do not enter surface or ground waters or contaminate soils.	At all times.
Pesticides are stored in enclosed areas.	At all times.
Spilled pesticides are cleaned up and waste materials kept in designated enclosed areas.	At all times.
Pesticide application equipment is capable of immediate shut off in the event of an emergency.	At all times.
Pesticides are never sprayed within 100 feet of open waters or any drainage ditches.	At all times.
Public posting of area to be sprayed.	As necessary.
All incoming equipment that may be stored temporarily outdoors is inspected for leaks.	As necessary.
Drip pans are placed under parts or equipment that are likely to drip liquids.	At all times.
No wash water, liquid waste or other pollutant is conveyed to storm drains.	At all times.
Floor drains are all connected to the sanitary sewer.	At all times.

Work areas are not hosed down.	At all times.
Catch basin cleaning and proper disposal of sediments and liquids.	When debris reaches 60% sump depth or 6 inches below outlet.
Ensuring that storm sewer capacities are not exceeded.	As needed.
Employees properly trained so that paint and other materials from painting do not enter storm drains.	As needed.
Drip pans beneath all mounted taps and drip/spill locations during tank filling.	At all times.
Sweep and clean tank storage area.	As needed.
Permanent tank located in an impervious secondary containment surrounded by dikes.	At all times.
Secondary containment sloped to drain to a dead-end sump.	At all times.
Tank overfill protection system in place.	At all times.
Inspection of process area and stormwater system	Monthly.

- **Preventive Maintenance**

The Maintenance Specialist - Planning oversees the preventive maintenance program. Preventive maintenance involves the regular inspection, testing, and cleaning of facility equipment and operational systems. These inspections help uncover conditions that might lead to a release of materials, thus allowing for maintenance to prevent such a release. Preventive maintenance records are kept indefinitely in the Computerized Maintenance Management System. Hard copies of these records are stored two years in the Maintenance Resource Room and an additional five years in the Storage Building.

The following BMPs are included in our preventive maintenance program:

Preventive Maintenance BMPs	
BMP	**Frequency**
Prevent the discharge of unpermitted liquid or solid wastes and sewage to ground or surface water or to storm drains which discharge to surface water or to the ground.	At all times.
Floor drains in potential pollutant source areas are not connected to storm drains, surface water or to the ground.	At all times.
Cleaning of all oily parts, steam cleaning and pressure washing of equipment or containers is conducted inside a building and water is directed to a sanitary sewer.	At all times.
Drip pans to collect leaks and spills from equipment stored outside.	At all times.
Temporary storage of solid wastes contaminated with liquids or other potential pollutant materials is in dumpsters, garbage cans, drums and comparable containers which are durable, corrosion resistant, non-absorbent, non-leaking, and equipped with a solid cover or stored under a covered structure.	At all times.

Where exposed to stormwater use containers, piping, tubing, pumps, fittings, and valves that are appropriate for their intended use and for the contained liquid.	At all times.
Where feasible potential stormwater pollutant materials are stored inside a building or under cover and/or containment.	At all times.
Minimize the use of toxic cleaning solvent and other toxic chemicals.	Where possible.
Recycle waste materials such as solvents, coolants, oils, degreasers, and batteries to the maximum extent possible.	Where possible.
Empty drip pans after a spill or leak	As needed.
Warning signs at stormwater catch basins and drains - "Dump no Waste".	In place.
Repair or replacement of storm drainage system structures.	As needed.
Inspect tank containment areas to identify problem components such as fittings, pipe connections, and valves for leaks/spills, cracks, corrosion, etc.	Every 1-2 weeks.
Preventive Maintenance BMPs	
BMP	**Frequency**
Repair or replace tanks that are leaking, corroded, or otherwise deteriorating.	As needed.
Installations comply with the Uniform Fire Code and the National Electric Code.	At all times.

- **Additional BMPs**

A schedule for implementation of additional or enhanced BMPs that are necessary is as follows:

BMP Implementation			
BMPs	**Description of Action(s) Required for Implementation**	**Schedule Milestones and Completion Date(s)**	**Person Responsible for Action**
Good Housekeeping	**1.**		
	2.		
	3.		
Preventative Maintenance	**1.**		
	2.		
	3.		
	1.		

Spill Prevention & Emergency Cleanup	**2.**		
	3.		
Inspections	**1.**		
	2.		
	3.		

- **Spill Control Plan**

The Post Point Wastewater Treatment Plant has a current Spill Control Plan that addresses spill prevention and emergency cleanup. The plan describes safety measures, where spill cleanup kits are located, material handling procedures, storage requirements, appropriate cleanup equipment and who is trained to respond to spills. It also outlines procedures for notifying authorities, spill containment area, diversion, isolation and cleanup. The Spill Control Plan is kept in the Operations Control Room and a copy also accompanies this SWPPP. A log of all spills, including date, time, amount, location and reason for the spill will be made by operations and maintenance staff and kept with the SWPPP.

It is of greatest importance that spills be contained and cleaned up as quickly as possible to decrease the probability that a pollutant will be discharged to the stormwater systems. Spill and clean up materials must be disposed of properly.

All listed chemicals have leak detection devices and are continuously monitored for leaks. Good housekeeping practices are described in section 6.1 of this SWPPP. Areas where potential spills could contribute to stormwater discharges are the chemical unloading areas identified on Figure 1.

The Water Quality Specialist trains the operations staff annually on spill response procedures. Training consists of oral and video presentations as well as a review of the storm drain areas in the plant and demonstrations on plugging storm drains to prevent spilled materials from entering the storm drain system.

- **Employee and Contractor Training**

Training is essential in the implementation and maintenance of the SWPPP. The purpose of the training program is to inform employees at all levels that they are important components in assuring that the goals of the SWPPP are met. Properly trained personnel are more capable of preventing spills, responding safely and effectively to an accident should one occur, and recognizing situations that could lead to stormwater contamination.

Plant maintenance and operations employees will receive training from the Water Quality Specialist annually. Training will be conducted by written, oral, or video presentation. New employees will be trained during on-boarding and within 30 days of hire. Contractors will attest to having received training before performing work inside the process area. Training will include an overview of what is in the SWPPP and the importance of employee diligence and participation to ensure compliance with the SWPPP by preventing contamination of stormwater. This training will include spill prevention and response procedures, good housekeeping, material management practices, and any

other topics deemed appropriate by the Water Quality Specialist, Technical Supervisor or Chief Operator.

A log of the dates on which specific employees receive training shall be kept and included in the SWPPP.

6.2 Structural Source Control BMPs

Structural control measures are necessary to control any pollutants that can be potentially present in stormwater after the non-structural controls have been implemented. To the maximum extent practicable, and to the extent it is cost effective, the use of source area control BMPs designed to prevent stormwater from becoming contaminated will be used. Source area control BMPs that are either proposed or in place are described in this section.

- **Preventive Measures**
  Preventive measures are controls that are intended to prevent the exposure of stormwater to contaminants. Preventive measures include signs and labels, safety posts, fences, security system, and coverings over areas of concern. Structures made of materials that may be mobilized to stormwater (i.e. galvanized steel) are painted to prevent exposure.

- **Diversions**
  Diversion practices are structures (including grading and paving) that are used to divert stormwater away from high-risk areas and prevent contaminants from mixing with the runoff. All traveled and unloading areas are paved. Curbing and grading channels stormwater into storm drains and away from areas of potential contamination. Stormwater from roof drains of all buildings is diverted to grassy or gravel areas to prevent zinc from galvanized pipes from entering the storm drains.

- **Containment areas**
  Containment areas are structures designed to hold pollutants or contaminated stormwater to prevent it from being discharged to surface waters. All storage tanks and hook-up valves are located within containment areas with sumps. All chemicals except diesel fuel are stored inside buildings.

  The 10,000-gallon diesel fuel containment is equipped with two sump pumps and a liquid level alarm. When liquid in the sump reaches a critical level, an alarm is set off in the Operations Control Room. An operator physically accesses the containment. If the liquid is stormwater that has collected in the containment, it is pumped to the sanitary sewer. If the liquid is diesel fuel, cleanup is initiated following the Emergency Response Plan.

  All delivery vehicles place drip containers under their hose hook-ups. Sewage delivery trucks unload inside a building. Dismantling and parts storage areas are located in the Maintenance Building where there is no potential for run-off into stormwater drains.

- **Other Controls**
  Additional controls are used at this facility. All maintenance and repair of equipment takes place inside the Maintenance Building. Catch basins are in place to control stormwater peak runoff rate and volume.

6.3 Treatment BMPs

Post Point Pollution Control Plant has two treatment BMPs that employ full onsite infiltration. The first is an infiltration trench treatment BMP collects and treats all stormwater from drainage A. The infiltration trench BMP was installed in August of 2011 as part of a citywide initiative to improve water quality via the installation of green and low impact stormwater facilities. The second is a large raingarden BMP that collects and treats all stormwater from drainage C. The raingarden BMP was installed in 2014 as part of a plant upgrade. The locations of the two treatment BMPs and the drainages they service are illustrated in figures 2 and 3.

6.4 Erosion and Sediment Control Measures

Areas prone to soil erosion shall be protected and the soil kept out of the stormwater discharge. All traveled areas in the facility are paved. All other areas are planted and landscaped to prevent soil erosion. There are currently no areas of existing or potential soil erosion.

7.0 Record Keeping and Reporting

The following pages contain blank forms for the record keeping and reporting associated with the SWPPP. All reports and records pertaining to the permit coverage under this general permit shall be retained for three years beyond the date of the implementation of the SWPPP. The forms are to be kept on site and shall be made available to the Department of Ecology upon request.

Sampling results will be summarized, reported, and submitted on a Discharge Monitoring Report (DMR) via the eDMR system (secureaccess.wa.gov) for each reporting period. The DMR may be submitted any time after completing the required monitoring but must be filed with the Department of Ecology within 45 days following the end of the reporting period. An annual report summarizing any corrective actions must be submitted using a form provided by the Department of Ecology no later than May 15th of each year. Reports are to be submitted electronically via the secureaccess.wa.gov portal. Any letters or other correspondence with the Department of Ecology can be sent to:

Industrial Stormwater Permit Manager Department of Ecology Water Quality Program PO Box 47696 Olympia, WA 98504-7696	Melinda Wilson Permit Administrator 360-870-8290 MEWI461@ecy.wa.gov

All laboratory reports providing data for conventional metal parameters must include sampling date, sampling location (SWPPP identifier), date of analysis, parameter name, CAS number, analytical method/number, method detection limit (MDL), laboratory practical quantitation limit (PQL), reporting units, and concentration detected. These records must be maintained on site and are not submitted to the Department of Ecology unless requested.

DMR forms must be submitted whether or not the facility was discharging. Discharge monitoring forms must also be submitted if monitoring has been suspended as a result of consistent attainment of benchmark values. If there was no discharge during a given monitoring period, the form should be submitted with the "no discharge" box checked. If monitoring has been suspended based on consistent attainment, the form should be submitted with the "consistent attainment' box checked.

The results of visual monitoring will be recorded and signed by principal executive officer or ranking elected official or by a duly authorized representative of that person. Authorization has been made in writing and submitted to the Department of Ecology (refer to National Pollution Discharge Elimination System Waste Discharge Permit No. WAR005561). Signed, recorded results of visual monitoring shall be kept with the SWPPP.

The Water Quality Specialist will make monthly inspections to evaluate the effectiveness of the SWPPP. The inspections shall be adequate to verify that the site drainage conditions and potential pollution sources described in the SWPPP are being implemented, properly operated, and adequately maintained. Information reported shall include the inspection date, inspection personnel, scope of the inspection, major observations, and revisions needed to the SWPPP.

For each measurement or sample taken the following information shall be recorded: the date, exact location, method, and time of sampling or measurement; the individual who performed the sampling or measurement; the dates the analyses were performed; the individual who performed the analyses; the analytical techniques or methods used; and the results of all analyses.

7.1 Corrective Action Tracking and Follow-up Procedure

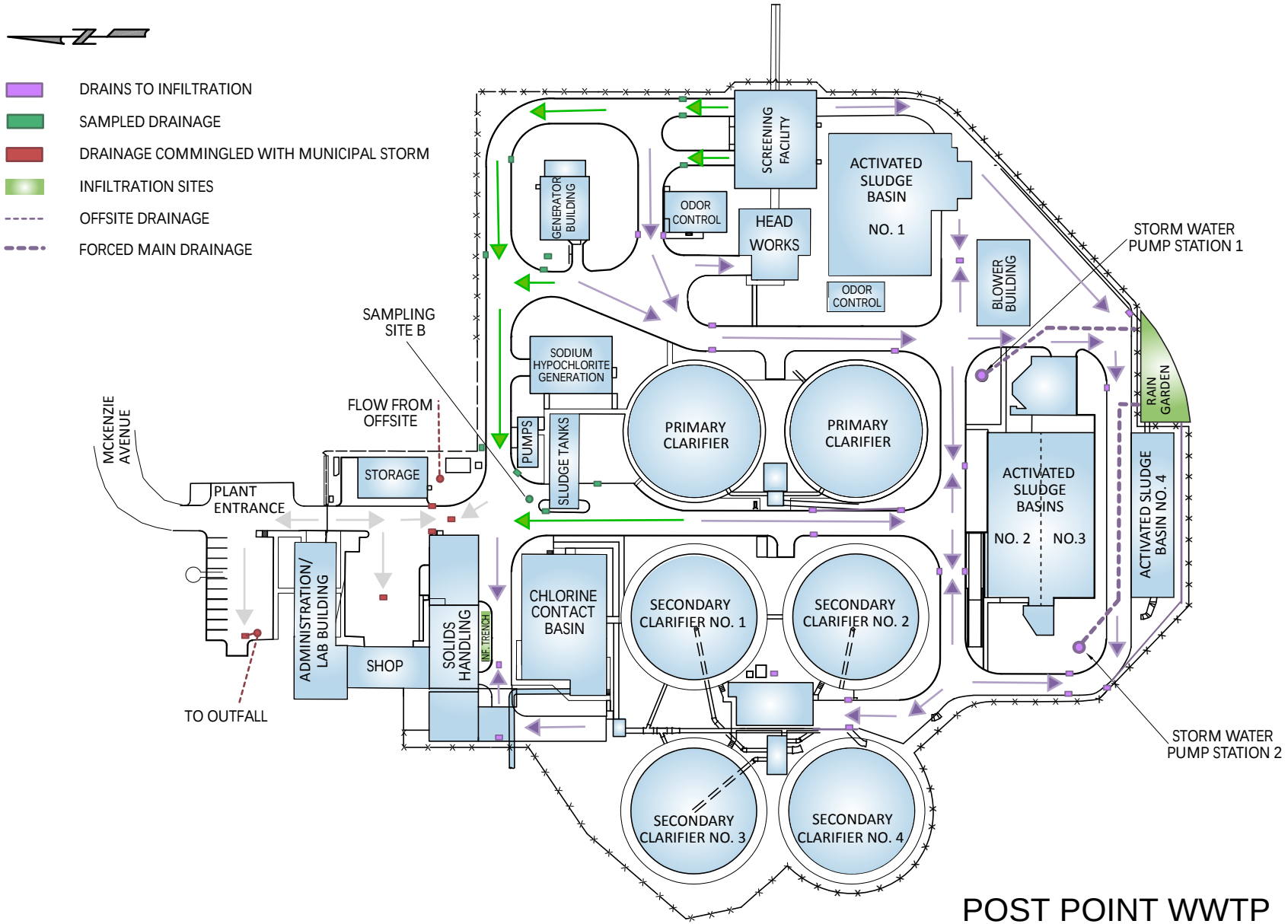
In the event of corrective action being needed, the following course of action will be followed.

1. Immediately upon receipt of stormwater analysis indicating exceedance of benchmarks the Stormwater Pollution Prevention Team will be notified, and inspection of the stormwater conveyance system and area of influence will be conducted by the Water Quality Specialist.
2. Findings of the above inspection will be reported to the Operations and Technical Supervisors, including a list of suggested actions.
3. A schedule to implement changes and a corrective action progress report will be established.
4. Upon completion of corrective action, sampling will be conducted to verify that adequate measures were taken to control the stormwater pollutant in question.
5. All inspection, schedules, progress reports, actions taken, and sampling results will be included in the annual Industrial Stormwater Report to Ecology.

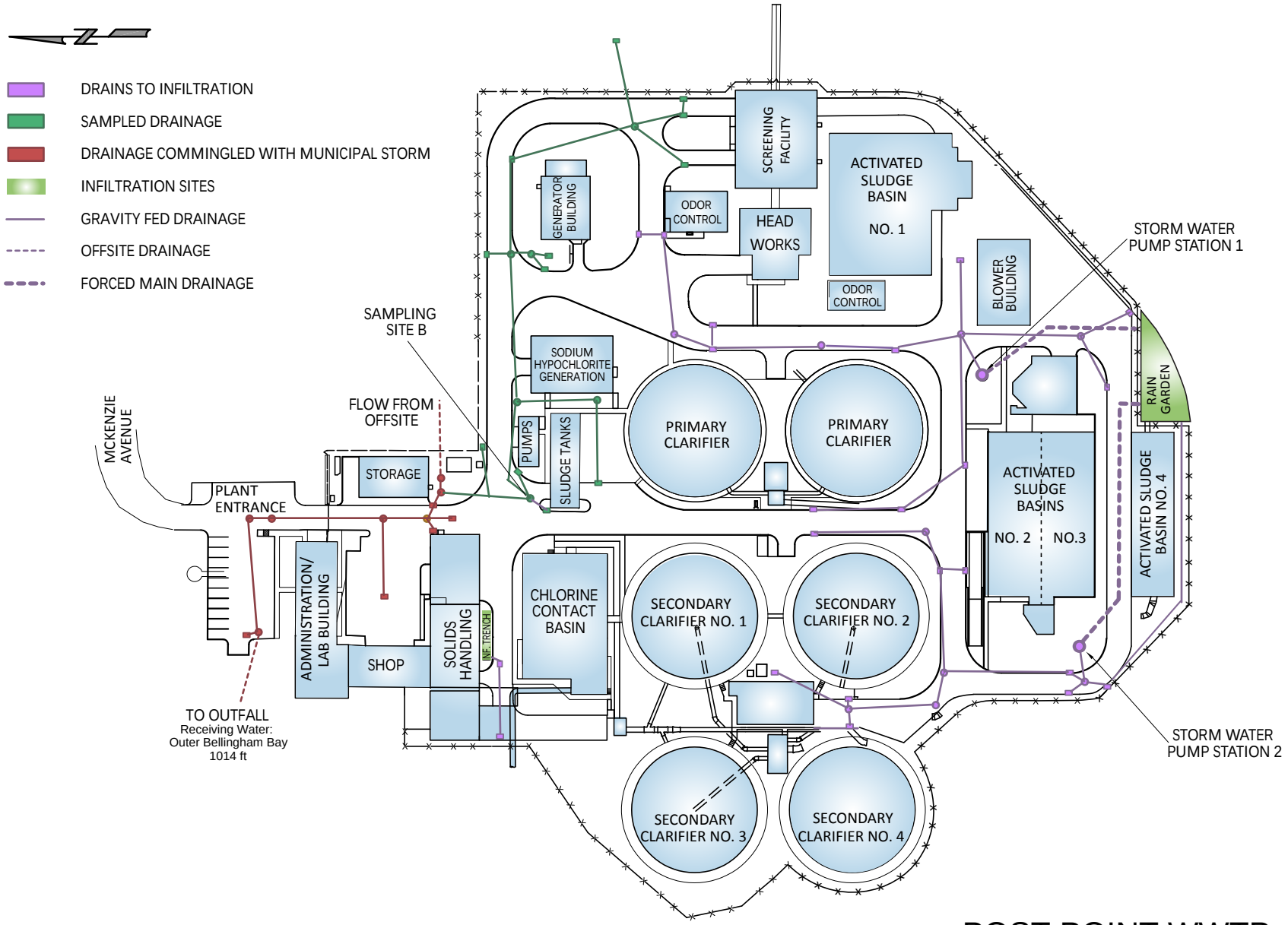
City of Bellingham Employee Training in Stormwater Pollution Prevention Plan	
DATE:	**TOPIC:**
Print Name	Signature

City of Bellingham
Stormwater Pollution Prevention Plan
TURBIDITY AND PH BENCH SHEET

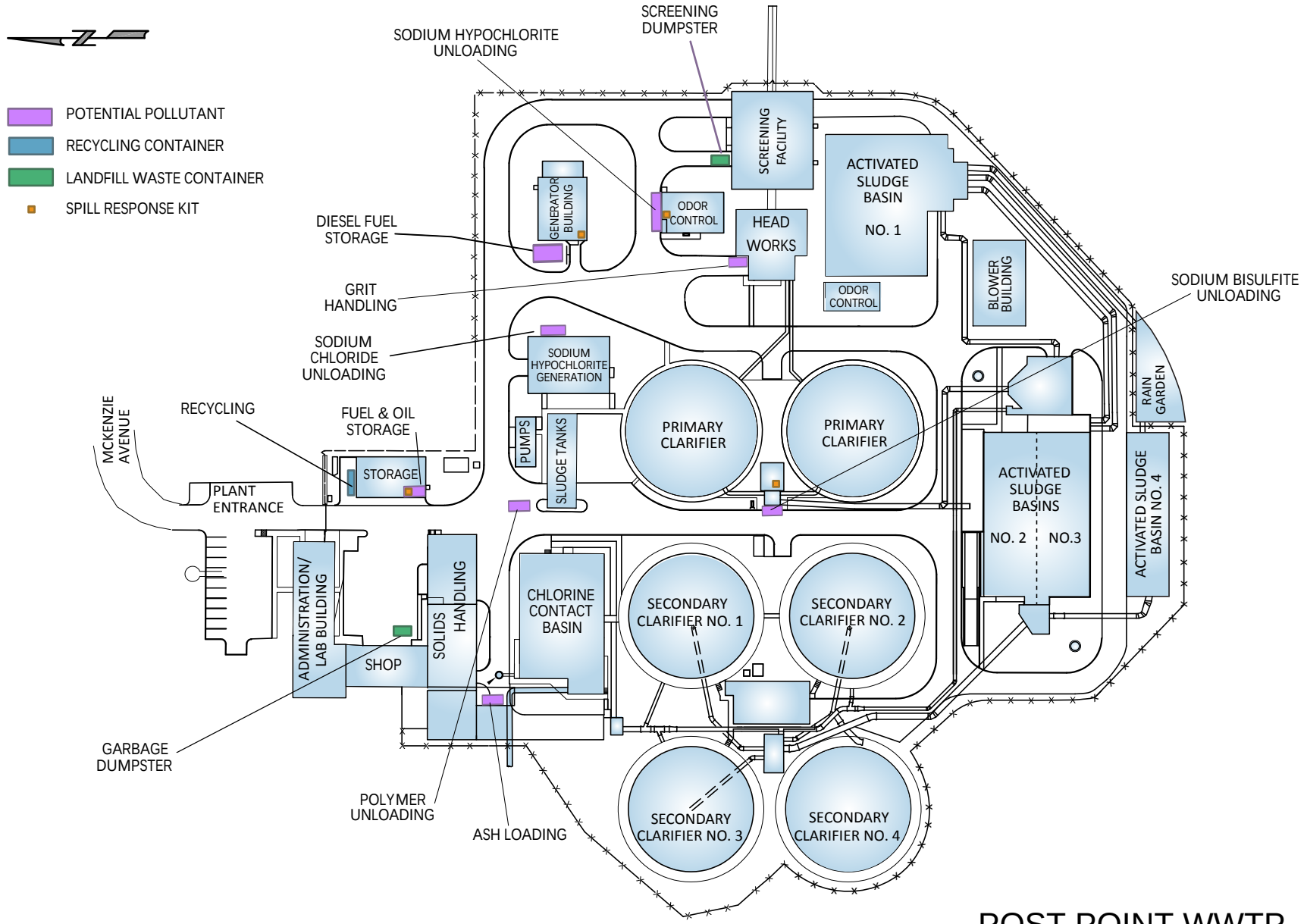
Collection Date	Collection Time	Initials	Sampling Location	Turbidity (NTU)	pH	Analysis Time	Initials



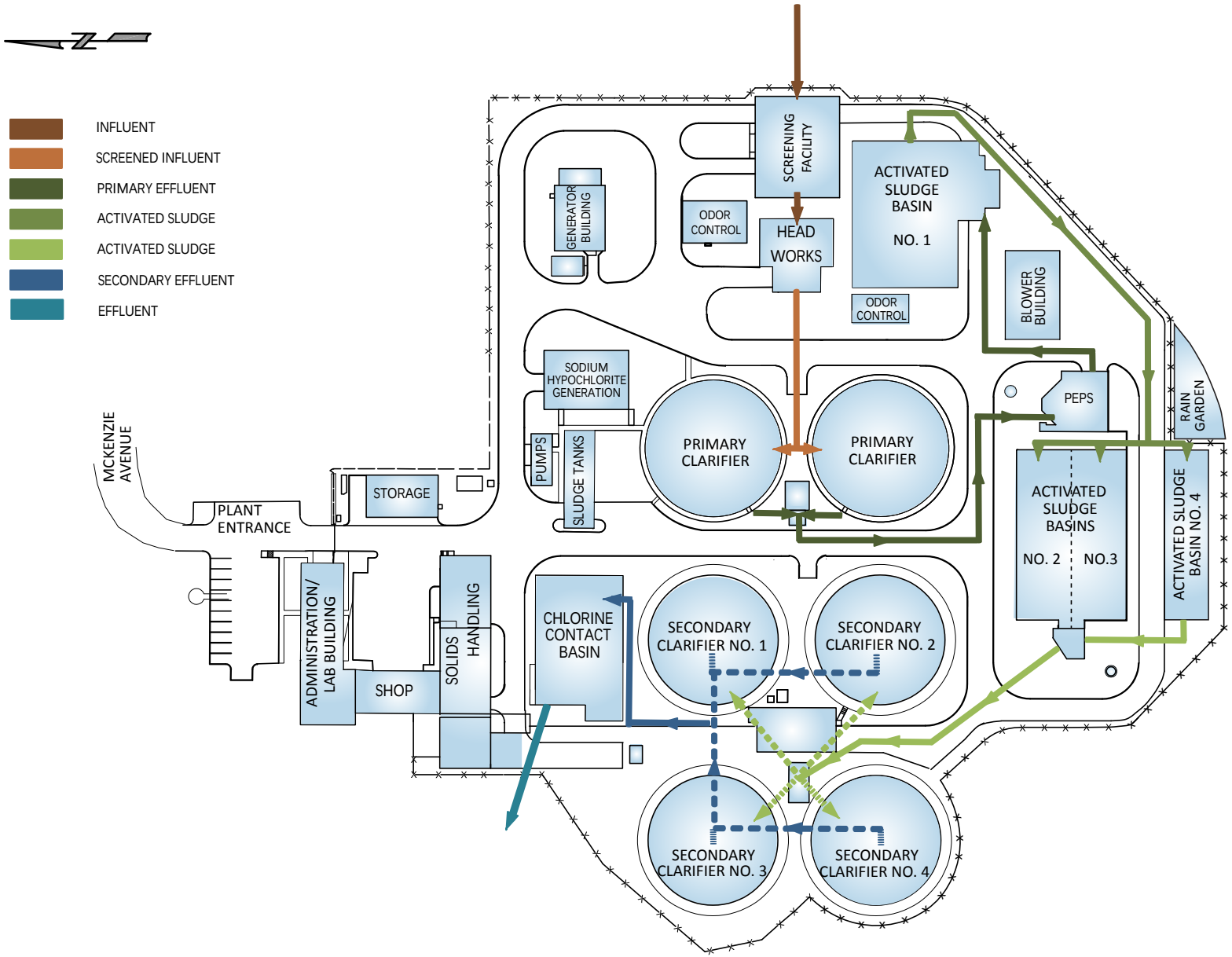
POST POINT WWTP SURFACE FLOW SCHEMATIC



POST POINT WWTP DRAINAGE SCHEMATIC



POST POINT WWTP POLLUTANT SOURCE SCHEMATIC



POST POINT WWTP SCHEMATIC

Stormwater Requirements at Post Point Treatment Plant



Stormwater that flows on-site at the Post Point Wastewater Plant is regulated by the state of Washington. **You are an important part of keeping this water clean** before it makes its way to Bellingham Bay.

By law, the Post Point Treatment Plant is required to meet all terms and conditions of a stormwater permit or face fines and penalties issued by the Dept. of Ecology. We are required to document that all people that work at the treatment plant know how to keep the stormwater on site free from contamination.

Requirements:

The treatment plant has a Stormwater Pollution Prevention Plan (maintained by Water Quality Specialist in Lab) that details all measures taken to avoid pollutants entering the Post Point stormwater system. Included in the plan are:

- Detailed schematics of all plant process, plant layout, stormwater systems, chemical transfer locations, storage areas, containment measures, waste receptacles, and any other sites of possible pollutant discharge.
- Training people working at the treatment plant for ways to avoid stormwater contamination.
- Chemical inventory.
- Copies of all relevant spill control and emergency response plans.
- Types, schedules, and locations where *Best Management Practices (BMP)* are employed to provide *All Known, Available, and Reasonable methods of prevention, control, and Treatment (AKART)* of stormwater pollution.
- Prohibited discharges.
- Monitoring is required to be performed on stormwater with results submitted to the state
- Laboratory results, inspection results, quarterly *Discharge Monitoring Reports (DMRs*) and annual reports.
- Emergency contacts of all responsible personnel.

How you fit in:

The staff and contractors at Post Point the first line of defense in preventing pollutants from entering stormwater. Be aware of the process and your surroundings to keep watch for any leaky containers, spills, chemical overfeed, loose waste debris or debris piles that could impact stormwater quality. There are storm drains all around the plant and its parking lots and any of the following are **strictly prohibited** from entering Post Point storm drains:

- Fuels, oils, cleaning agents, sealing agents, solid and/or liquid chemicals of any kind.
- Process water (all stages, including W-3 & W-4).
- Potable water (yes, you read that correctly).
- Solid waste, septage, and avoidable dirt and debris.
- Anything that's not stormwater (paint chips, lawn chemicals, pressure wash water, etc.)

Spill Prevention and Control:



Spill prevention is the best spill control. Spills at Post Point Treatment Plant are most likely to occur due to equipment failure, during chemical delivery/offloading operations, and during cleaning and maintenance activities. You can help prevent contamination by placing berms around or sealing storm drains to prevent wastewater from entering the conveyance system, by sweeping/cleaning any spilled materials, by keeping chemical applications away from paved surfaces, and by applying all material transfer procedures for chemicals used in the treatment plant.



Always be on the lookout for signs of accidental spills. If a spill does occur, work quickly to keep materials from entering the storm drain. If help is needed, contact one of the people indicated at the bottom of this page to assess a spill for danger, and for help with steps to take. Spill response kits are available for your use to assist in cleanup. Never attempt to clean up a spill of an unknown and potentially dangerous spill alone. Inform your supervisor so appropriate hazardous materials handling can occur.

If the spilled material is a known substance and you have been trained in the proper spill response procedures and required personal protective equipment (PPE), an attempt may be made to contain the spill and/or prevent it from moving offsite. Make sure you understand appropriate clean-up procedures, know where to find spill clean-up supplies, and report the spill immediately to Post Point staff.

Spill Response Kits are located in the following areas in the treatment plant (call for help finding):

- Odor control/scrubber system building
- Generator building
- Sodium bisulfite storage room
- Fuel and oil storage room

City staff to contact in the event of a spill:

Name	Title	Phone
Yohann Misquitta	Chief Operator	(360) 778-7853
Rich Hoover	Water Quality Specialist	(360) 778-7874
Operator on Duty	Operator	(360) 778-7855

I certify that I have read and understand Post Point Stormwater requirements:

Business: _____ Name: _____ Date: _____

Staff Signatures

Printed Name	Signature	Date

APPENDIX C:
ARCHAEOLOGICAL RESOURCES INADVERTENT DISCOVERY PLAN
POST POINT SLUDGE TANK REPLACEMENT PROJECT
EU194

The Post Point Wastewater Treatment Plant and project location are classified as very high risk for containing archeological sites. The attached Inadvertent Discovery Plan shall be followed during all excavation and ground disturbing work. Additionally, project crew(s) conducting the ground disturbing work shall receive an Inadvertent Discovery Plan Training from the Project Archaeologist. All contractor costs to adhere to the IDP and attend required training shall be incidental to the contract.

Final

POST POINT RESOURCE RECOVERY PLANT PRIMARY SLUDGE TANK REPLACEMENT PROJECT, BELLINGHAM, WHATCOM COUNTY, WASHINGTON

Archaeological Resources Inadvertent Discovery Plan

Submitted to
Carollo Engineers

Prepared for
City of Bellingham Public Works Department

Prepared by
Brian Durkin, M.S.

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Appendix A – Unanticipated Archaeological Discoveries Response Form

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Figure 1 Post Point Resource Recovery Plant Primary Sludge Tank Replacement Project, Detail 2

1. INTRODUCTION

This Inadvertent Discovery Plan (IDP) has been developed for use by the City of Bellingham (City) during its construction of the Post Point Resource Recovery Plant Primary Sludge Tank Replacement Project (Project). The Project is located within the Post Point Resource Recovery Plant (Plant) in the Fairhaven neighborhood of Bellingham in Whatcom County, Washington. The Plant is owned and operated by the City. The Project address is 200 McKenzie Avenue, Bellingham, Washington 98225 and is within Section 2 of Township 37 North, Range 2 East, on the Eliza Island, WA 7.5' series topographic map (Figure 1). It is located on Whatcom County Assessor Parcel Number 3702114035380000.

1.1 Purpose of Plan

This IDP has been developed for use by the City during ground disturbing construction for the project. It provides a generalized approach to identifying, protecting, and resolving inadvertent discoveries of cultural resources that may be eligible for inclusion in the National Register of Historic Places (NRHP). This plan is intended to provide guidance to City project personnel to:

A. comply with applicable Federal and State laws and regulations,

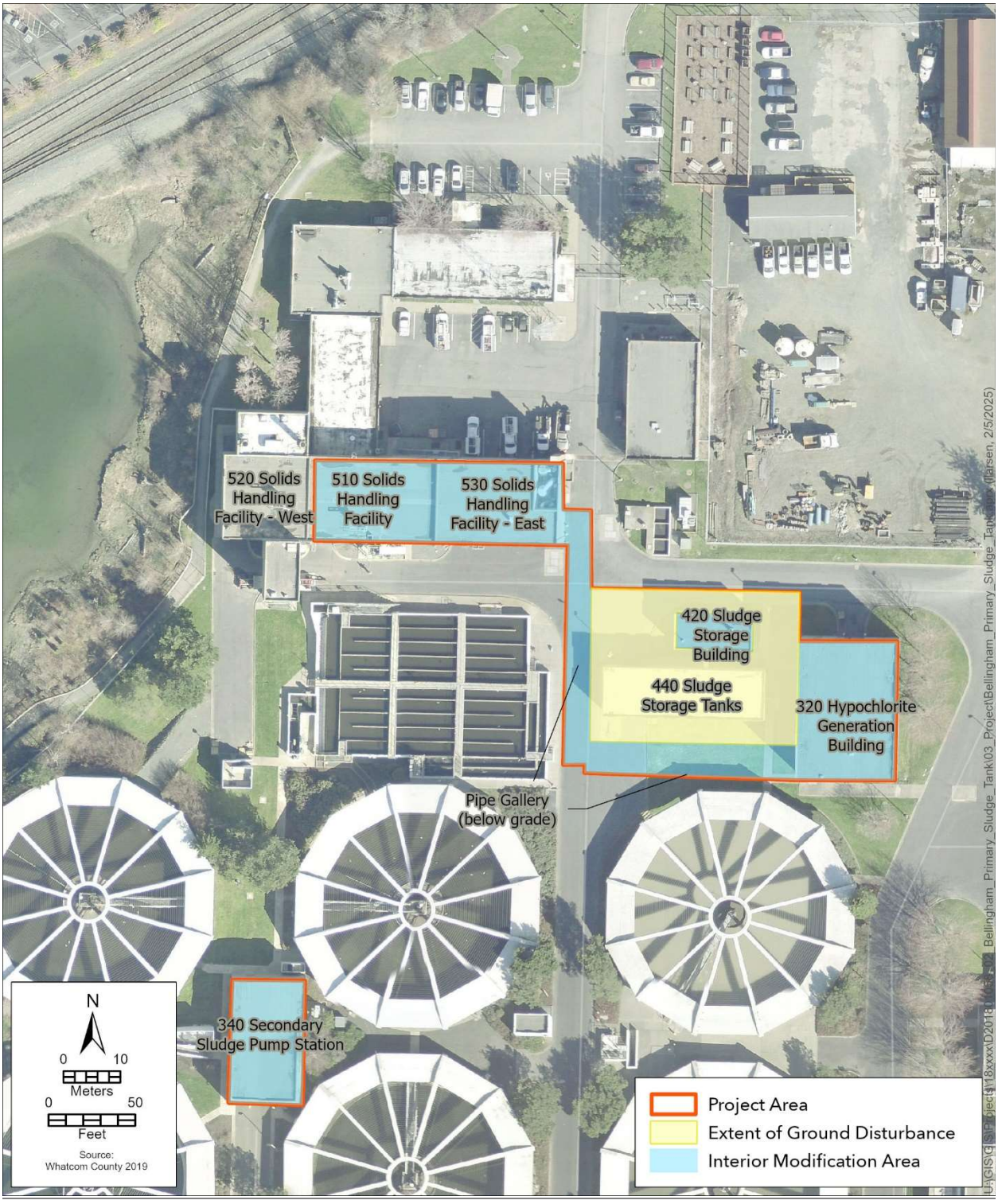
B. describe the procedures that the City will follow to prepare for and respond to inadvertent discoveries, and

C. provide direction and guidance to project personnel on the proper procedures to be followed should an inadvertent discovery occur.

Implementing the terms of this IDP is the responsibility of the City Project Manager.

1.2 Regulatory Environment

The Project is subject to compliance with Chapter 43.21C of the Revised Code of Washington (RCW) – the State Environmental Policy Act (SEPA). SEPA requires that historic and cultural preservation is considered as part of the environmental review process. The local authority administering this SEPA action is the City. The City oversees/reviews cultural resources within its jurisdiction in cooperation with the Washington State Department of Archaeology and Historic Preservation (DAHP). Additional laws that apply to archaeological projects conducted within the State of Washington include: Archaeological Sites and Resources (Revised Code of Washington [RCW] 27.53), Indian Graves and Records (RCW 27.44), Human Remains (RCW 68.50), and Abandoned and Historic Cemeteries and Historic Graves (RCW 68.60).



Prepared by ESA

Figure 1
Post Point Resource Recovery Plant Primary Sludge Tank Replacement Project Area

1.3 Project Location

The Project is located within a portion of the existing Plant, on Whatcom County Assessor parcel number 3702114035380000 (200 McKenzie Avenue, Bellingham, Washington 98225). The horizontal boundaries of the Project Area are shown in Figure 1**Error! Reference source not found.**. The vertical boundaries of the Project Area are currently anticipated to be a maximum depth of 15 feet below surface. The Project Area includes all buildings and structures with proposed modifications, based on project understanding at this time.

1.4 Project Description

The Project is still in the design phase. Currently, the Project design includes the following key components at the Post Point Resource Recovery Plant (Plant). Maximum depths of disturbance are estimated to be 10 to 15 feet below surface. For a map of building locations, see Figure 1.

- **Hypochlorite Generation Building 320**
  - Equipment modifications.
- **Secondary Sludge Pump Station Building 340**
  - Demolition of existing waste activated sludge / return activated sludge pumps and addition of new dewatering / return activated sludge pumps and associated piping inside the building basement.
- **Sludge Storage Building 420**
  - Demolition and installation of equipment inside building to support the new sludge storage tanks.
  - Structural retrofits including adding exterior doors and extending the grade-level floor across the building.
- **Sludge Storage Tanks 440**
  - Demolition of abandoned building in its entirety and removal of surrounding soils.
- **Solids Handling Building 510**
  - Demolition of the existing sludge storage tank inside building.
- **Solids Handling Building 530**
  - Replacement of thickened sludge pumps inside the building basement.
- **Construct two new 50,000-gallon tanks** with approximate dimensions of 18 feet long, 18 feet wide, and 24 feet tall each. The new sludge storage tanks will be constructed with reinforced concrete and will be mixed with top-mounted impeller mixers.
- **Piping revisions and new WAS pumps** inside the existing underground pipe gallery.
- S**ite restoration/stormwater/yard piping** will occur within excavation limits stated above.

2. INADVERTENT DISCOVERY PROCEDURES

2.1 Human Remains

If ground disturbing activities encounter human skeletal remains during the course of construction, then all activity must cease that may cause further disturbance to those remains. The area of the find must be secured and protected from further disturbance. The remains should not be touched, moved, or further disturbed. **See Section** Inadvertent Discovery of Human Remains **3.1 - Inadvertent Discovery of Human Remains.** The finding of human skeletal remains must be reported to the Whatcom County Medical Examiner's Office and the Whatcom County Sherriff's Office in the most expeditious manner possible.

2.2 Resources Not Requiring Documentation

The following materials are presumed not significant and would not require recording beyond normal daily monitoring notes or a halt in construction. If in doubt, the City Project Manager should contact the Project Archaeologist.

- Isolated cans or bottles;
- Clusters of 10 or fewer similar historical-period objects (such as paint cans or beer bottles);
- Charcoal/slag related to locomotive clean-outs;
- Abandoned utilities;
- Fragmented brick, asphalt, or concrete.

2.3 Resources Requiring Documentation

The types of materials that would require a temporary halt for further investigation include:

- Suspected human remains (**see Section 3.1- Inadvertent Discovery of Human Remains**);
- Layers of charcoal and/or concentrated shell;
- Animal bones, stone tools, or other Native American artifacts;
- Concentrations of rock (rock pavements, hearths, firepits, walls);
- Hewn wooden posts (house posts, food drying racks);
- Building or structural foundations, including articulated lumber;
- Basketry or fiber objects (cedar twine ropes, woven mats, cedar twine fishing nets); and
- Assemblages (10+ items) of varying objects: cans, bottles, ceramic dishware, bricks, or other historic debris. In order for these assemblages to require notification of the Project Archaeologist, they must represent multiple artifacts, not one or two artifacts broken into many fragments.

3. INADVERTENT DISCOVERY RESPONSE

In the event that a suspected archaeological resource is encountered, the Contractor / Subcontractor will immediately halt work within the area of discovery, mark and secure the area of discovery, and notify the City Project Manager. The area of stoppage will be adequate to provide for the security, protection, and integrity of the suspected resources. The suspected resources will not be handled, removed, reburied, or covered. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery area. Spoils piles or trucks that may contain archaeological resources will remain on site.

The City Project Manager will notify the Project Archaeologist. The City Project Manager will be responsible for immediately collecting basic information including names of construction personnel, location, time and date, field conditions, equipment, and nature and extent of the discovery. This information should be recorded using the attached form (Appendix A). Construction may proceed elsewhere provided that it will not disturb the discovery location.

The Project Archaeologist will attempt to assess the discovery remotely using information provided by the City Project Manager or their designee (e.g., verbal descriptions, emailed photos, etc.). If the Project Archaeologist is unable to make an assessment, a field visit will take place. If the discovery is determined to be archaeological, an evaluation and eligibility assessment will be prepared for the City to distribute to the DAHP and Affected Tribes. Depending on the results of the assessment, the Project Archaeologist may provide the following responses:

1. **The resources are not archaeological site.** The Project Archaeologist notifies the City Project Manager, who authorizes the resumption of work. The Project Archaeologist provides a summary email to the City Project Manager regarding the assessment.
2. **The resources are an archaeological site and are recommended Not Eligible for the NRHP**. The City Project Manager will consult with the SHPO at DAHP and Affected Tribes regarding the eligibility recommendation.
    a. If the consulting parties determine and concur the site is **Not Eligible**, the City Project Manager will authorize resumption of work and any additional direction on treatment.
    b. If the consulting parties determine and concur the site is **Eligible**, then further consultation to determine treatment actions will be required. Work may not resume within the find area until site treatment has been agreed upon by the City Project Manager and the SHPO at DAHP.
3. **The resources are an archaeological site and are recommended Eligible for the NRHP**. The City Project Manager will consult with the SHPO at DAHP and Affected Tribes regarding the eligibility recommendation. If the City Project Manager and SHPO concur with the recommendation of Eligible, further consultation to determine treatment actions and NRHP eligibility will be required. Work may not resume within the find area until site treatment has been agreed upon by the City Project Manager and the SHPO.

3.1 Inadvertent Discovery of Human Remains

If any human remains are inadvertently discovered, **all work adjacent to the discovery shall cease immediately**. A 50-foot work stoppage area shall be established around the discovery. Vehicles, equipment, and unauthorized personnel shall not be permitted to traverse or enter the discovery site.

The Contractor / Subcontractor will notify the City Project Manager without delay. If the Contractor / Subcontractor is unsure if the material is human remains, they will still contact the City Project Manager. If the City Project Manager cannot determine if materials are human remains, they will contact the Project Archaeologist.

Once the discovery is confirmed as human remains, or is suspected as such by the Project Archaeologist, the City Project Manager will then notify the Whatcom County Medical Examiner's Office and Bellingham Police Department via the non-emergency telephone number without delay.

Personnel making the discovery shall not leave the discovery unattended prior to the arrival of law enforcement or county medical examiner.

The following text is the DAHP's preferred language regarding the inadvertent discovery of human skeletal remains to be used in the development of inadvertent discovery protocols (DAHP 2024):

> *"If ground disturbing activities encounter human skeletal remains during the course of construction, then all activity will cease that may cause further disturbance to those remains. The area of the find will be secured and protected from further disturbance until the State provides notice to proceed. The finding of human skeletal remains will be reported to the county medical examiner/coroner and local law enforcement in the most expeditious manner possible. The remains will not be touched, moved, or further disturbed. The county medical examiner/coroner will assume jurisdiction over the human skeletal remains and make a determination of whether those remains are forensic or non-forensic. If the county medical examiner/coroner determines the remains are non-forensic, then they will report that finding to the Department of Archaeology and Historic Preservation (DAHP) who will then take jurisdiction over the remains. The DAHP will notify any appropriate cemeteries and all affected tribes of the find. The State Physical Anthropologist will make a determination of whether the remains are Indian or Non-Indian and report that finding to any appropriate cemeteries and the affected tribes. The DAHP will then handle all consultation with the affected parties as to the future preservation, excavation, and disposition of the remains."*

4. REFERENCES

Department of Archaeology and Historic Preservation

2024 Recommended Inadvertent Human Remains Discovery Language. Electronic document, https://dahp.wa.gov/archaeology/human-remains/recommended-inadvertent-human-remains-discovery-language, accessed January 18, 2024.

5. CONTACT INFORMATION

To be updated by the City PM with current contact information prior to start of construction.

Primary Field Contacts	
City of Bellingham Project Manager	[TBD] (xxx) xxx-xxxx, [Email]
Contractor Project Manager	[TBD] (xxx) xxx-xxxx, [Email]
Project Archaeologist	Brian Durkin, Environmental Science Associates (509) 435-2255, bdurkin@esassoc.com
Agency Contacts	
State Department of Archaeology and Historic Preservation	Allyson Brooks, State Historic Preservation Officer (360) 586-3066 Guy Tasa, State Physical Anthropologist (360) 586-3534
Whatcom County Medical Examiner's Office	Allison Hunt, M.D. 360-738-4557
Bellingham Police - non-emergencies line Emergencies	(360) 676-6911 911
Tribal Contacts (to be notified by City Only)	
Lummi Nation 2665 Kwina Road Bellingham, WA 98226-9298	Lena Tso, THPO 360-312-2257 lenat@lummi-nsn.gov
Nooksack Tribe 5016 Deming Road Deming, WA 98244	Trevor Delgato, THPO 360-303-9310 tdelgado@nooksack-nsn.gov
Samish Indian Nation 2918 Commercial Ave. Anacortes, WA 98221	Jackie Ferry, THPO 360-293-6404 ext. 126 jferry@samishtribe.nsn.us

Appendix A
Unanticipated Archaeological Discoveries Response Form

Unanticipated Archaeological Discoveries Response Form

Name of person completing this form: _____ _____ (Name)

_____ (Affiliation)

Date _____ **Time** _____

Who made the discovery? _____ (Name)

_____ (Affiliation)

_____ (Name)

_____ (Affiliation)

Who was contacted regarding the discovery? _____ _____ (Name)

_____ (Affiliation)

How was contact made? (phone/email/text/etc.) _____

When was contact made? (date/time) _____

Were pictures sent? ☐ Yes ☐ No **If so, to whom?** _____ (Name)

How were the pictures sent? (text/email/etc.) _____

Where was the discovery made? (station number/trench location/etc.) _____

_____

What were the field conditions? _____

What type of equipment was being used? (if there was an excavator, did the bucket have teeth?)

_____

Describe the discovery (i.e. is it artifacts or a sediment deposit; types of materials; does it look to be in fill): _____

_____

_____

How large of an area does the discovery cover (how large of an area is visible)? _____

_____

Draft City of Bellingham Inadvertent Discovery Protocol

June 2026

1. Introduction

Washington State law requires that developers and landowners consider the impact of projects on archaeological resources, and that development projects either avoid impact or mitigate damage to these resources whenever possible. The first step in impact avoidance of cultural resources is through identification of the different types of archaeological resources that may be encountered in the process of ground disturbance. This IDP does not include an exhaustive list of archaeological resources but is meant to serve as a guide and reference for the types of archaeological resources commonly encountered in the Pacific Northwest to aid in their identification by non-archaeologist project personnel. Furthermore, this IDP may be applied to any project undertaken by the City and may be coupled with the procedures for archaeological monitoring. In the event of a suspected inadvertent discovery, this protocol is designed to ensure regulatory compliance and to mitigate potential damage to potentially sensitive archaeological resources.

2. Archaeological Resource Examples

Archaeological resources include both artifacts and features. Artifacts are individual items made and/or used by humans in the past, such as cans, bottles, stone tools, and modified animal bone or unmodified shell. Features are concentrations of artifacts or structural elements from past human activities, such as fire pits, trash pits, or discard piles.

For ease of reference, artifacts and features in the Pacific Northwest are generally described as either *pre-contact* or *historical*. Pre-contact archaeological resources are associated with the Indigenous cultures of the region, prior to widespread European colonization of the area, whereas historical archaeological resources are often associated with the arrival of European immigrants. The following provides examples of commonly encountered archaeological resources in the Pacific Northwest, whilst not providing an exhaustive list. If in doubt as to whether an item is potentially an artifact or feature, please notify your project's designated Archaeologist.

2.1 Pre-Contact Archaeological Resources

Pre-contact archaeological resources are artifacts and deposits made by Native Americans before around 1850. Examples of pre-contact archaeology may include, but are not limited to stone tools, stone flakes and chips, hearths, and shell middens. Additional details about these resources are provided below.

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Stone tools (commonly referred to as “lithics” in archaeological parlance) are items produced by chipping or “knapping” small flakes of stone, or by grinding and abrading a stone to form it into the desired shape. They can often be identified by their shape and through the presence of “flake scars” indicating where stone has been removed in the production process. Stone tools are often made of fine-grained stones such as chert/flint, obsidian, and finer grained volcanic stones such as dacite. Often, stone tools will be more finely grained than surrounding rocks and gravel where they are found.



Debitage or “flakes” are a common byproduct of stone tool production, produced when one stone is hit against another. Flakes can also be utilized as tools, can take multiple forms, and may be difficult to ascertain from other, non-archaeological rocks. Often, stone flakes will be more colorful or finely grained than surrounding rocks and gravel where they are found, as well as angular or flat and not waterworn.



Hearths, also known as firepits, can be identified by the presence of charcoal and red, black, or dark brown edges or layers that may stand out against the surrounding soil. Sometimes, a hearth may contain fire-cracked rocks that can often, but not always, be covered in a black, almost greasy stain on the outside.



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Shell middens are commonly located adjacent to water and are formed of shellfish remains, including clams, mussels, and oysters. Other artifacts including stone tools and debitage, as well as discarded animal bones, can often be found within shell middens. They are often present as a very dark, black layer of soil with a greasy quality and will likely contain both intact and fragmented shells.



2.2 Historical Archaeological Resources

Historical archaeology in the Pacific Northwest spans from the late 19th to mid-20th century and encompasses a wide variety of possible items of various sorts, including, but not limited to, personal items, building materials, and consumer goods. In the case of items such as glass bottles and ceramic dishes, they may often be difficult to ascertain as archaeological. If in doubt, consult with an Archaeologist.

Glass bottles, similar to recent examples, come in a variety of shapes, sizes, and colors. Dates may be attributed to bottles and other glass vessels by distinguishing features such as maker's marks, lettering, or in rare examples, surviving labels.



Ceramics, similar to contemporary examples, also take multiple forms and functions, including but not limited to eating, drinking, and cooking vessels, electrical insulators, and tobacco pipes. They may have decorations and maker's marks that can provide possible dates for their manufacture. Ceramics may come in a variety of colors, but white is most common.

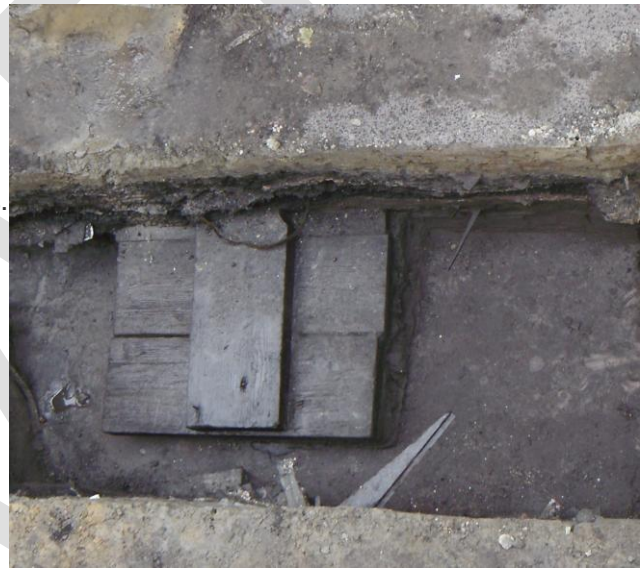


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Faunal remains refer to the skeletal remains of animals, oftentimes domesticated. These can range from pets and draught animals, such as dogs, cats, and horses, to commonly used food animals, including cows, pigs, and sheep. In the latter case, straight cuts from saws are similar to those found on butchered bones in the present day in a grocery store.



Building materials, similar to present day examples, include items such as bricks, nails, and angular wooden planks, boards, and beams. Historical nails are commonly wire (round head) or machined (flat head). Machine cut nails were commonplace until the early 20th century and can therefore provide an estimation of a date range for any associated artifacts.



Hollow filled features include holes in the ground that may or may not have been filled in. These can include storage pits, privies (outhouses), and wells. They may sometimes be identified by linings of brick, stone, or wood, which delineate their boundaries, and they can often contain historical artifacts.



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Architectural features broadly encompass the remains of past structures, including foundations of previous buildings, as well as walls, piers, pilings, and other human-made structures. These features have as many variations as there are different types of structures.



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Historic logging infrastructure includes remnants of logging activities, including camps, mills, tramways or railroads, poll roads, skids, springboards, ropes, cables, and other structures.



Logging road



Logging skid



Springboard

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3. Inadvertent Discovery Protocol

3.1 Archaeological Resources

If confirmed or suspected archaeological resources are encountered during project-related ground disturbance, the following protocols are to be enacted both to prevent further damage to potential archaeological resources and to ensure compliance with relevant laws.

1. If a suspected archaeological resource is encountered by any party on a work site, all activities in the area surrounding the suspected archaeological resource will cease, and a buffer large enough to protect the discovery will be instituted—no less than 30 feet. No unauthorized foot, vehicle, or equipment traffic may traverse the buffer area, beyond what is necessary to vacate the vicinity without posing any impact to the integrity of the discovery.

2. The on-site construction/contractor manager will immediately notify the consultant Archaeologist (Contact #1), the City of Bellingham Project Manager (Contact #2), and the City of Bellingham Department Cultural Resources Coordinator (Contact #3). No work within the vicinity of the discovery can commence unless verbal and written confirmation has been provided by the Archaeologist.

    a. The consultant Archaeologist will meet the Secretary of the Interior's Standards for a qualified professional Archaeologist (36 CFR 61, RCW 25.48.020[4])) or will work under the direct supervision of a professional Archaeologist as provided in RCW 27.53.030(8).

3. The consultant Archaeologist will document and photograph the discovery and its location in order to ascertain whether or not it is an archaeological resource. Following the examination by the Archaeologist, they will institute the following potential scenarios given the circumstances of discovery:

    a. If the Archaeologist confirms that the discovery is not an archaeological resource, then they will authorize a continuation of work, and ground-disturbing activities may resume.

    b. If the Archaeologist ascertains that the discovery is archaeological, but not within an original depositional context, such as fill or in an area of previous ground disturbance, or if the discovery is a historical isolate, then the location of the discovery will be recorded and the item collected by the Archaeologist. To be considered an isolate, a discovery is defined as a singular item in an undisturbed depositional context, and not within two meters of a feature or another artifact. The Archaeologist may then authorize the resumption of ground-disturbing activity.

    c. If the consultant Archaeologist determines that the discovery is archaeological, but not an isolate in secondary depositional context or a historical isolate, they will then take necessary steps to secure the discovery and immediately contact the DAHP Local Government Archaeologist (Contact #7). The DAHP Local Government Archaeologist will contact the affected Native American Tribes to formulate an action plan for the preservation of the discovery. Until this time, no ground disturbance may occur within a 30-foot buffer around the discovery site, and all ground disturbance outside this buffer must be monitored by a consultant Archaeologist.

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3.2 Human Skeletal Remains

Any human remains inadvertently discovered through the process of ground disturbance must be treated with dignity and respect. Upon discovery of potential human skeletal remains, the following set of protocols must be put into action:

1. If anyone on site believes they have encountered human remains, all work in the vicinity of the suspected remains must immediately cease in order to protect the security and integrity of the remains in accordance with RCW 27.44 and 68.50 of Washington State Law.
2. The on-site construction/contractor manager will immediately contact the consultant Archaeologist (Contact #1), City of Bellingham Project Manager (Contact #2), and City of Bellingham Department Cultural Resources Coordinator (Contact #3) to inform them of the discovery.
3. A minimum buffer of 30 feet will be secured surrounding the discovery. Unauthorized personnel and vehicles will not be allowed to enter the buffer area.
    a. The on-site construction/contractor manager must ensure that all on-site staff do not speak with the media, take photographs of or disturb the remains, or release any information about the discovery on social media.
4. Following the work stoppage and creation of a buffer, the consultant Archaeologist will immediately call the Whatcom County Medical Examiner (Contact #4) and Bellingham Police Department (Contact #5) or Whatcom County Sherriff's Office (Contact #6), as appropriate. The medical examiner will ascertain if the human remains are related to a recent crime, or if they are non-forensic. Throughout this process, the remains are not to be disturbed.
5. If the remains are found to be non-forensic, the medical examiner will then inform the DAHP Local Government Archaeologist (Contact #7). DAHP will then take jurisdiction over the remains, and the State Physical Anthropologist (Contact #8) will determine if they are Native American or non-Native American.
6. In the event that the remains are found to be Native American, DAHP will identify and inform relevant Tribes and conduct consultation with the Tribes to determine the course of action for the remains. If they are found to not be Native American or forensic, DAHP will likewise consult with relevant parties regarding the treatment and preservation of the remains.

At all times, non-authorized personnel may not further disturb any human skeletal remains beyond the circumstances of their first discovery. Unauthorized photographs and the dissemination of any photographs of human remains must not occur. When possible, the consultant Archaeologist will ensure that the remains are respectfully kept out of view without disturbing their integrity.

3.3 Contact List

1. Consultant Archaeologist – Assigned for each project.
2. City of Bellingham Project Manager – Assigned for each project.
3. City of Bellingham Department Cultural Resources Coordinator – Assigned by Department.
4. Whatcom County Medical Examiner – 360-738-4557, medicalexaminer@co.whatcom.wa.us.
5. Bellingham Police Department – 360-778-8800.
6. Whatcom County Sheriff's Office – 360-778-6600, Sheriff@co.whatcom.wa.us.

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7. DAHP Local Government Archaeologist – Tamela Smart, 360-628-2755, Tamela.smart@dahp.wa.gov.
8. DAHP State Physical Anthropologist – Guy Tasa, Ph.D., 360-790-1633, Guy.Tasa@dahp.wa.gov.

3.4 Tribal Contact List

The contact list below was created in September 2025. Contacts should be verified periodically as representation will change over time.

Affiliation	Phone
Confederated Tribes of the Colville Reservation, Tribal Historic Preservation Officer	509-634-2695
Lummi Nation, Tribal Historic Preservation Officer	360-312-2257 (office) 360-961-7752 (cell)
Lummi Nation, Deputy Tribal Historic Preservation Officer	360-312-2253 (office) 360-927-2944 (cell)
Nooksack Indian Tribe, Cultural Resources Director	360-592-5176 ext. 3232
Nooksack Indian Tribe, Tribal Historic Preservation Officer	360-592-5176 ext. 3234
Samish Indian Nation, Tribal Historic Preservation Officer	360-293-6404 ext. 126
Sauk–Suiattle Indian Tribe, Director	360-436-0333
Sauk–Suiattle Indian Tribe, Tribal Historic Preservation Officer	360-436-0333
Snoqualmie Indian Tribe, Director, Archaeology and Historic Preservation	425-292-0249 ext. 2010 425-495-6097 (cell)
Snoqualmie Indian Tribe, Cultural Resource Compliance Manager	425-292-0249 ext. 2010
Swinomish Indian Tribal Community, Tribal Historic Preservation Officer	360-466-7352
Upper Skagit Indian Tribe, Natural and Cultural Resources Policy Representative	360-854-7009

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