APPENDIX B

HORIZONTAL BORE DESIGN SERVICES REPORT

The report was utilized in the preparation of the Contract Documents and project design, but was not prepared for purposes of bid development, and its accuracy may be limited based on locations of field observations and tests indicated in the report. The Contractor is cautioned to make a complete evaluation of site soil conditions, including consultation with consultants or geotechnical professionals as applicable. During bidding, the Contractor shall make his/her own deductions and conclusions as to the nature of the materials to be excavated and the difficulties that may arise from subsurface conditions.

SBR Discharge Pipe Horizontal Bore Design Services

City of Aumsville, Oregon
WWTP Improvements
Aumsville, Oregon

for
Westech Engineering, Inc.

May 20, 2026

5711 South Hood Avenue, Suite A
Portland, Oregon 97239
503.624.9274

GeoEngineers

SBR Discharge Pipe Horizontal Bore Design Services

City of Aumsville, Oregon
WWTP Improvements
Aumsville, Oregon

File No. 15356-003-01
May 20, 2026

Prepared for:

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Table of Contents

List of Figures

Appendices

Executive Summary

PROJECT NAME:	City of Aumsville Waste Water Treatment Plant	**OWNER ID/NAME(S):**	City of Aumsville
LOCATION:	Aumsville, Oregon	**CROSSING NAME(S):**	SBR Discharge Pipe Horizontal Bore

PARAMETERS

	CASING PIPE PARAMETERS		**BORE PARAMETERS**
DIAMETER (in):	36-inch O.D.	**MINIMUM COVER (ft)**	5
MATERIAL:	Steel	**MAXIMUM PIT DEPTH (ft)**	18
YIELD STRENGTH (psi):	35,000 (min)	**RECCOMENDED METHODS**	Auger Bore
MAOP (psi):	N/A		Pipe Ram
WALL THICKNESS (in):	0.500		

SUBSURFACE CONDITIONS

EXLORATIONS:	CGS (2025a) & CGS (2025b)	**GROUNDWATER:**	Seasonally to ground surface. Noted at approx. 5 feet bgs in August.
SOIL CONDITIONS:	Medium stiff to stiff cohesive soils (silt, lean clay, elastic silt, and fat clay) with varying sand and gravel content.	**BEDROCK CONDITIONS:**	N/A

CONSTRUCTION RISKS & CONSIDERATIONS

HORIZONTAL BORE OPERATIONS

- Workspace considerations – Workspaces are located adjacent to mapped wetlands.
- Hole Stability - Risk of squeezing or flowing soils may require the use of controlled face bore methods.
- Obstructions – Cobbles and boulders are common in local geology.

The Executive Summary should be used only in context of the full report for which it is intended.

1.0 Introduction

1.1 GENERAL

GeoEngineers, Inc. (GeoEngineers) is pleased to submit this report providing geotechnical engineering and cased bore (bore) design recommendations for the proposed SBR Discharge Pipe Horizontal Bore associated with the City of Aumsville (City) Wastewater Treatment Plant (WWTP) project in Aumsville, Oregon. The site location is shown with respect to the surrounding area in the Vicinity Map, Figure 1.

1.2 PROJECT DESCRIPTION

The City of Aumsville (City) is planning improvements to their existing WWTP located at 955 Olney Street SE in the City of Aumsville. The project includes the installation of a new 36-inch-diameter steel casing to house a 24-inch-nominal-diameter sequent batch reactor (SBR) discharge pipeline beneath Beaver Creek by horizontal boring (auger bore, pipe ram) methods. The design horizontal length of the proposed trenchless crossing is 135 feet as measured along the proposed alignment centerline. The layout of the crossing is shown in the design drawing included in Appendix A. The casing and carrier pipe specifications for the proposed crossing is presented below in Table 1.

TABLE 1. PIPE SPECIFICATIONS

DESIGN PARAMETER	PROPOSED SPECIFICATION
Casing Pipe Specification	36-inch O.D.[A] x 0.500-inch w.t.[B] Grade B (minimum)
Carrier Pipe Specification	24-inch AWWA C905 PVC or 26 inch DR17 HPDE (per bid documents)
Crossing Length	135 feet

Notes:
[A] O.D. – outside diameter
[B] w.t. – wall thickness

2.0 Scope of Services

Our specific scope of services is summarized in our proposal dated January 6, 2025. The following is an abbreviated description of our scope of services for this project:

1. Performed a desktop review of pertinent information including: site-specific topographic survey provided by Westech, Central Geotechnical Services, LLC's (Central Geotechnical's) geotechnical reports, aerial photographs of the site on Google Earth software, and geologic maps.
2. Completed horizontal bore design and engineering for the crossing, including estimated settlement over the pipeline based on the depth of the alignment, soil type, and diameter of the casing pipe, and designed the horizontal bore alignment and depth based on generally accepted practices in the trenchless industry.
3. Provided an engineered drawing set of the proposed pipe ram crossing suitable for bidding and construction.

4. Prepared this report summarizing the results of our evaluation, engineering analysis, and providing our conclusions and recommendations.

3.0 Site Conditions

3.1 SURFACE CONDITIONS

Our understanding of the site surface conditions is based on observations during a site reconnaissance conducted on January 14, 2025, site specific survey provided by Westech, and a review of available aerial photography on Google Earth software.

Beaver Creek appears to have been channelized to flow southeast to northwest in a relatively straight alignment between two pairs of existing wastewater treatment lagoons within the Aumsville WWTP. The creek is located within an approximately 300- to 350-foot-wide undeveloped corridor between the lagoons. The ground surface slopes gently upward on either side of the creek channel. The channel of the creek ranges between about 15 feet to 50 feet in width and approximately 3 feet deep (relative to surrounding grades). Water flowing within the channel was several feet deep during our winter site reconnaissance. Based on our conversation with City of Aumsville personnel, we understand the waters in Beaver Creek diminish greatly during the summer months. Mapped wetlands ranging between 70 feet to 165 feet in width are located along the creek. The City of Aumsville's proposed bore alignment extends beyond the mapped wetlands on either side of the creek. Existing site conditions are shown in photographs presented in Figures 2 through 4.

3.2 GEOLOGICAL CONDITIONS

The Geologic mapping we reviewed (Tolan and others 2000; Gannett and Caldwell 1998) indicates that the project alignments are underlain by Holocene-aged alluvial deposits. The Holocene-aged alluvial deposits are described as unconsolidated silt, sand, and gravel between 0 and 15 feet in thickness. Based on units mapped adjacent to the proposed alignments, we anticipate that the recent alluvial deposits are underlain by Pleistocene-aged alluvial deposits. These deposits are described in the mapping as "poorly indurated" siltstones, sandstones, conglomerates of older alluvial terrace or fan deposits up to 90 feet in thickness. The mapping also includes clays and silts deposited by the catastrophic Missoula Floods in this unit. As discussed in the CGS geotechnical report (CGS 2025a), much of the site is mantled by fill materials from previous grading at the WWTP.

3.3 SUBSURFACE CONDITIONS

3.3.1 General

Our understanding of subsurface conditions at the site is based on our review of the CGS (2025a) geotechnical report for the project and subsequent geotechnical data memorandum (CGS 2025b). CGS completed numerous geotechnical borings and Cone Penetration Test (CPT) soundings within about 500 feet of the proposed Beaver Creek crossings. Of these explorations, we selected three borings within 5 feet to 200 feet of the proposed trenchless alignments as a basis for characterizing subsurface conditions near the proposed trenchless alignment. We chose borings based on proximity to the alignment and representative position along the Beaver Creek stream channel. The CGS explorations we considered are listed as follows:

- MW-2: Geotechnical boring and piezometric monitoring well located approximately 10 feet southwest from the proposed horizontal bore receiving pit.
- B-5: Geotechnical boring completed approximately 30 feet from the proposed horizontal bore launching pit.

The locations of CGS explorations we selected for use in analysis are shown or described relative to the proposed horizontal bore alignment in the Design Drawing in Appendix A. Graphic logs of CGS borings are also provided in the profile of the Design Drawing. The graphic logs of CGS's borings are provided for informational purposes only and should not be considered a warranty of subsurface conditions along the horizontal bore profile.

3.3.2 Subsurface Description

Subsurface materials encountered in CGS's borings were generally consistent with the geologic mapping we reviewed, with the exception of near surface fill documented in CGS's borings. We summarized subsurface conditions relative to each of the trenchless alignments below. Refer to CGS's geotechnical report (CGS 2025a) and geotechnical memorandum (CGS 2025b) for more detailed geotechnical information.

3.3.2.1 BORING MW-2

In general, the boring log for boring MW-2 (CGS 2025b) shows about 22 feet of typically stiff to very stiff lean clay overlying medium stiff sandy elastic silt with gravel that extends to 31.5 feet, the maximum depth explored. The log notes an interbed of fat clay with "relict rock structure" from 6 to 10 feet bgs. Based on Atterberg limits tests performed on four soil samples, plasticity indices of soils in the boring closed ranged from 19 to 22 percent.

3.3.2.2 BORING B-5

In general, the boring log for boring B-5 (CGS 2025a) shows stiff elastic silt with "relict rock structure" extending to 19 feet bgs (beyond the maximum depth of the conceptual launching and receiving pits); the log indicates high gravel content between 7 feet and 10 feet bgs. Soils below 19 feet bgs are described as medium stiff to stiff silt, lean clay, and elastic silt 86.5 feet bgs, the maximum depth explored.

3.3.3 Groundwater Conditions

A groundwater piezometer was installed in boring MW-2, which is located about 10 feet northwest of the proposed receiving pit. The following table provides a summary of groundwater readings obtained from the piezometer in boring MW-2 provided to us by Westech.

TABLE 2. DEPTH TO GROUNDWATER IN BORING MW-2

DATE	DEPTH TO GROUNDWATER
August 6, 2025	5.1 feet
August 12, 2025	3.6 feet
August 25, 2025	3.7 feet
September 4, 2025	3.7 feet
September 18, 2025	3.8 feet
November 6, 2025	0.0 feet

4.0 Crossing Design and Layout

4.1 ALIGNMENT AND PROFILE

The proposed crossing geometry is shown on the design drawing in Appendix A. The design geometry is primarily based on the following considerations: (1) placing the proposed launching and receiving pits outside of mapped wetlands; (2) placing the proposed tunnel zone 5 feet below the thalweg of Beaver Creek as depicted in CAD files provided by the project team; (3) confirming the tunnel zone elevation is located at elevations the borings encountered relatively low permeability lean clay or elastic silt soils; and (4) selecting a 36-inch-diameter permanent steel casing to house the proposed 24-inch AWWA C905 PVC or 26 inch DR17 HPDE carrier pipe.

Given the above considerations, the conceptual HAB is 135 feet long. The proposed launching and receiving pits are 18 feet deep and 16 feet deep, respectively. The minimum depth of cover beneath Beaver Creek is approximately 5 feet.

4.2 LAUNCHING AND RECEIVING PITS

The proposed launching pit excavation was laid out to be 40 feet long by 16 feet wide to accommodate a typical bore machine and 20-foot-long casing pipe joints. The receiving pit excavation was laid out to be 20 feet long by 10 feet wide. The dimensions of the launching/receiving pits depicted in the design drawing should be considered approximate and may need to be modified to accommodate the specific equipment, means and methods by the selected trenchless installation contractor.

4.3 CASING SELECTION

We recommend the contractor utilize a minimum 36-inch O.D. x 0.500-inch w.t. Grade B steel casing for the installation. The contractor should consider the anticipated jacking forces based on their specific means and methods and make a determination if heavier wall casing or higher yield strength material is required.

5.0 Settlement Analysis

We conducted settlement analysis for the planned trenchless crossing in general accordance with procedures outlined by Wallin et al. (2008). Our analysis assumes a 36-inch-diameter casing pipe installed at a minimum depth of 5 feet below the thalweg of Beaver Creek within medium stiff or stiffer cohesive soils. Based on our analysis, we estimate settlement at the ground surface over the crown of the casing to be less than ½ inch. Our settlement analysis assumes a maximum overcut of ½-inch radially and that no slurry (grout or bentonite/water) will be used to fill the annulus outside of the casing pipe that would otherwise support the annular overcut around the casing pipe.

6.0 Construction Considerations

6.1 LAUNCHING AND RECEIVING PIT EXCAVATION, DEWATERING AND SHORING

6.1.1 Excavation

We expect that conventional excavation equipment will be capable of excavating the launching and receiving pits. The actual pit sizes and depths should be adjusted by the boring contractor based on their selected equipment and practice and should be kept to a minimum to reduce impacts to existing surface features. Upon completion of the casing and carrier pipe installation, all temporary site modifications should be removed, and the affected areas should be restored to pre-construction conditions in accordance with the project site restoration plan and relevant permit conditions.

6.1.2 Dewatering

Based on soil and groundwater conditions encountered by Central Geotechnical's boring B-5 (CGS 2025a) and piezometer MW-2 (CGS 2025b) and the proposed excavation depths, it is likely that groundwater will be encountered by the bore pit excavations. Because of the presence of relatively low permeable sand and silt layers, we anticipate that sumps and pumps will be adequate to dewater the excavations. However, if significant groundwater infiltrations is encountered by the excavations, external dewatering measures such as well points could be required to maintain a dry and stable excavation. The contractor should have the responsibility of determining whether internal dewatering measures such as sumps and pumps are sufficient or if external dewatering measures are needed at the time of work.

The contractor should be prepared to handle the effluent that will be generated during any dewatering operations. The effluent may need to be treated in a settlement tank, sediment trap or basin in order to meet discharge permit requirements for sediment content. If permit requirements allow the effluent to be discharged onsite, we anticipate that the effluent would be required to be discharged in an upland area (outside of wetlands) and that filter bags or filter socks will be necessary at the end of the outfall pipe or hose to reduce sediment discharge.

6.1.3 Sloping and Shoring

Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. Because of the placement and depth of the launching and receiving pit excavations, we anticipate that all temporary cuts in excess of 4 feet high will be allowed to be shored or sloped in accordance with Occupational Safety and Health Administration (OSHA) regulation 1926 Subpart P, Appendix B – Sloping and Benching . For planning purposes, soils encountered within the exploratory borings in the vicinity of the bore crossing should be classified as Type C (soft clay, sand and gravel) soils. Temporary excavations in Type C soil should be inclined no steeper than 1.5H:1V. However, if caving occurs in excavation sidewalls, temporary excavations may need to be laid back to a shallower inclination and/or the excavations shored. These cut slope inclinations are applicable to excavations above the groundwater table only. Beneath groundwater elevation, sloughing and raveling will likely occur unless the excavation is dewatered to a sufficient depth below the base of the excavation using external dewatering measures such as well points.

In our opinion, the contractor should be responsible for designing and installing the appropriate shoring system needed to complete the work. We recommend that the project contract documents require the contractor to submit a shoring plan with their bid estimate. Because of the diversity of available shoring systems and construction techniques, the selection and 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 Oregon, and the Professional Engineer-stamped shoring plans and calculations be submitted to the owner's engineer prior to construction.

We recommend that a shoring system be used where excavations are located adjacent to private property, existing utilities, roadways or infrastructure 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; (2) groundwater is below the base of the excavation (either naturally or by dewatering); and (3) 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) and slide-rail systems of various types could be used where protection of existing slopes, utilities or structures is necessary.

If a trench box is used, yielding/ground movement is possible to a horizontal distance from the sidewalls, equal to 1.5 times the excavation depth. If groundwater is present in the excavation, the area of disturbance could be significantly greater.

For all excavations and/or protective systems, we recommend that:

- No traffic, construction equipment, stockpiles, or supplies should be allowed within a distance of at least 5 feet or a distance equal to half the depth of the excavation, whichever is greater, from the top of any cut unless a protective system is used and designed for the additional surcharge load.
- Sloped excavations should be laid back to a shallower inclination, benched, shielded and/or shored if spalling or caving of the sloped sidewalls is observed.
- Protective systems should be designed to prevent significant lateral movement of the native soils and should be of sufficient size to support the excavation without excessive ground deformation.
- Any water used during construction or stormwater runoff should be diverted away from the excavations.
- Construction operations should be scheduled to reduce the length of time the cuts are left open.
- Open excavations should be backfilled as soon as practical after extraction of the protective system.
- Caution should be used during extraction of the protective system to reduce disturbance to the installed casing pipe, underlying bedding fill material, and native soils.

6.2 CONSTRUCTION CONSIDERATIONS

6.2.1 Methodology

The project geotechnical reports (CGS 2025a & 2025b) indicates that the tunnel zone will likely encounter medium stiff to stiff cohesive soils (lean clay, elastic silt, and fat clay) with gravel. Groundwater will likely be encountered by the tunnel zone of the horizontal bore, and the launching and receiving pit excavations. The cohesive soils at tunnel zone elevations classify as “Squeezing” soils in accordance with the Tunnelman’s Ground Classification For Soils, as presented in Figure 5, thereby having the potential to squeeze or extrude plastically into the tunnel zone. If encountered, sandy soils within the tunnel zone would classify as “running” soils above the water table and “flowing” soils below the water table in accordance with the Tunnelman’s ground classification system.

Soils that flow into the tunnel face as a mixture of soil and water could result in rapid subsidence and sinkhole formation at the ground surface and beneath Beaver Creek. Soils that squeeze present a lesser, yet similar risk to a horizontal bore installation, and also present a risk of relatively high friction between the casing being installed and the surrounding soils. In our opinion, there is at least a moderate unmitigated risk of squeezing or flowing soil resulting in tunnel face collapse that could lead to surface subsidence and sinkhole formation that could result in the waters from Beaver Creek flowing into the tunnel zone and flooding the bore pits.

Mitigation for flowing or squeezing soils along the tunnel zone could possibly be accomplished by utilizing closed or controlled face methods such as nesting augers within the casing or by completing the crossing as a pipe ram. The risk of flowing or squeezing soils could further be reduced by completing the bore crossing during periods of extended dry weather, when flows within Beaver Creek are at seasonal lows. In addition, an overcut and bentonite ports could be used to inject bentonite fluid outside of the casing as a lubricant to reduce friction on the casing.

6.2.2 Obstructions

While not encountered in the borings along the bore alignment, the site geology suggests there is a potential for cobbles and/or boulders to be encountered in the subsurface. Underground obstructions such as cobbles have the potential to impede forward progress and affect the line and grade of a horizontal bore or pipe ram. Most auger bore systems can handle an obstruction up to one third the diameter of the casing pipe used during boring operations. However, pipe ramming methods allow the casing to ingest larger material. Even if larger boulder obstructions are encountered that halt the forward progress of the horizontal bore or pipe ram, 36-inch diameter casing is of sufficient size to facilitate manual mining of the obstruction using hand operated equipment.

7.0 Conclusions and Recommendations

7.1 GENERAL

Based on available information, the results of Central Geotechnical’s subsurface exploration program, and our engineering analyses, it is our opinion that the horizontal bore has a high likelihood of successful completion, provided the recommendations in this report are incorporated into both the preconstruction and construction phases of the project, and the bore contractor uses best industry practices, including those discussed in Appendix B.

We recommend that a prequalification process of the candidate bore contractors be initiated and then an agreement set in place with the selected bore contractor so that detailed construction procedures can be agreed upon through means of a written drill plan. We recommend that GeoEngineers be given an opportunity to review the plan prepared by the bore contractor to confirm that the considerations outlined in this report were adequately addressed.

We recommend contacting GeoEngineers immediately if subsurface conditions are claimed to be different than presented in this report. Because the subsurface conditions can vary outside of the limits of the borings competed at the site, we recommend GeoEngineers be on site during construction to document the process in real time, and to characterize and quantify risks that might reduce the potential for a successful installation of casing and carrier pipe.

7.2 BORE PLAN RECOMMENDATIONS

The bore contractor should address the items below in their bore plan to facilitate successful installation of the casing pipe and attempt to mitigate possible difficulties that could arise during the installation. The list below is intended to provide items that should be addressed based on site-specific construction considerations but does not include all items that are provided in a typical bore plan such as size and type of equipment to be used to complete the crossing, line and grade monitoring system, site layout, spoils management plan, and other standard plan requirements. The contractor's bore plan should include all items required in the contract specifications and the following recommended plan items.

- A contingency plan for excavation dewatering and effluent handling and disposal.
- A contingency plan in the event that squeezing or running soils are encountered along the tunnel zone.
- A contingency plan to mitigate difficulties maintaining line and grade during construction.
- A contingency plan in the event that obstructions impede the forward progress of the bore.
- Engineered shoring plans for the launching and receiving pits that are stamped by a professional engineer in the State of Oregon.

8.0 Limitations

We have prepared this report for use by Westech Engineering, Inc. and their authorized agents and other approved members of the design team involved with this project. The report is not intended for use by others and the information contained herein is not applicable to other sites. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions. The conclusions and recommendations in this report should be applied in their entirety.

Variations in subsurface conditions are possible between the explorations. Subsurface conditions may also vary with time. A contingency for unanticipated conditions should be included in the project budget and schedule for such an occurrence. We recommend that sufficient monitoring, testing, and consultation be provided by GeoEngineers during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions indicated during the work differ from those anticipated, and to evaluate whether earthwork and pipeline installation activities comply with contract plans and specifications.

The scope of our services does not include services related to construction safety precautions. Our recommendations are not intended to direct the Bore contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in developing a cased bore installation plan.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Appendix C, titled "Report Limitations and Guidelines for Use," for additional information pertaining to the use of this report.

9.0 References

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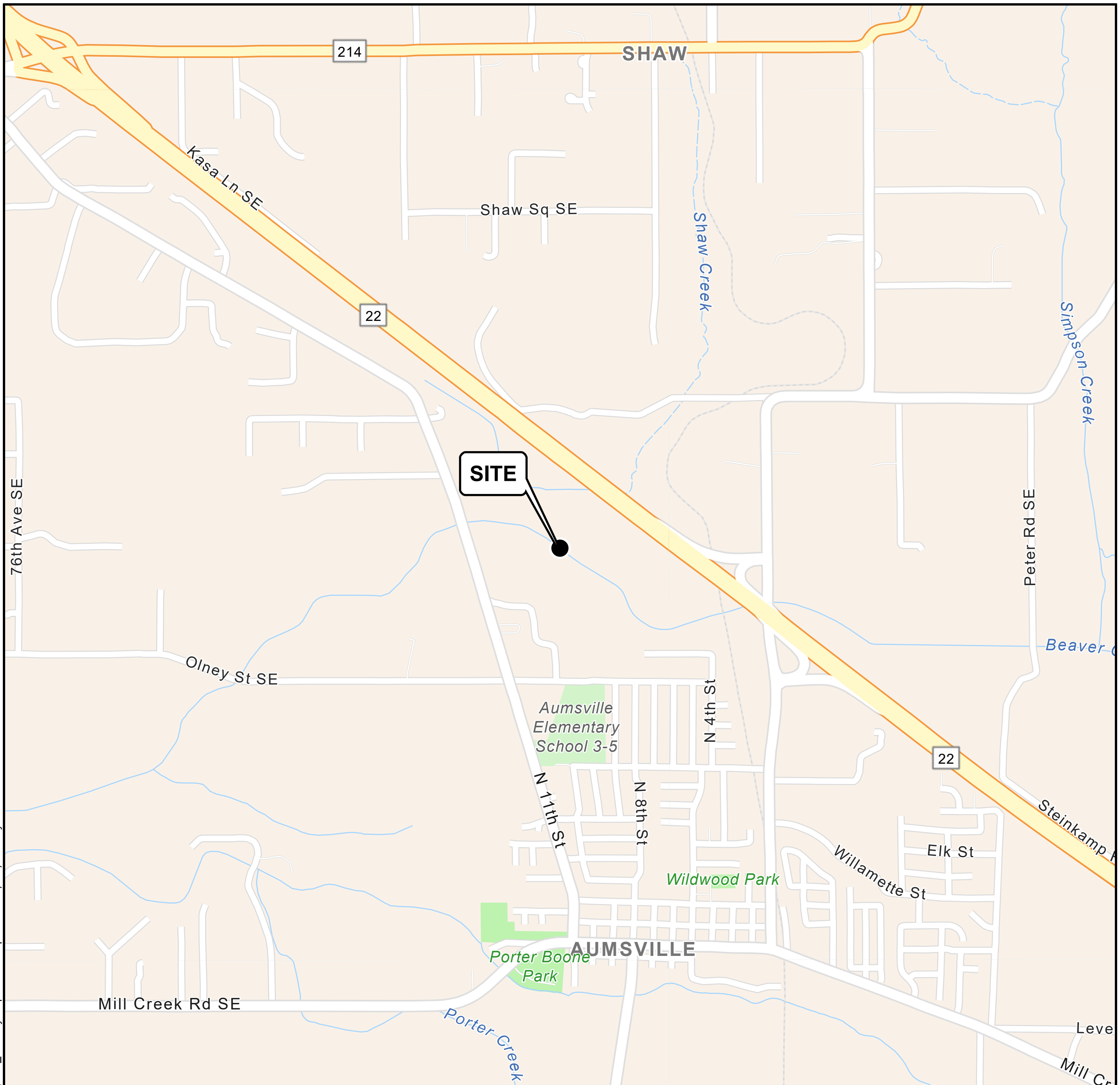
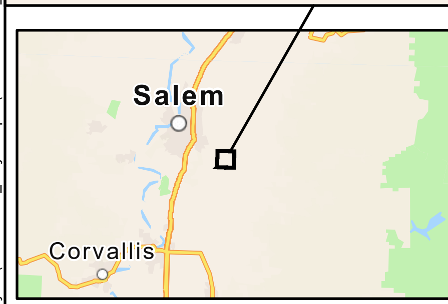
Figures





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Feet

Source(s):
- ESRI

Coordinate System: NAD 1983 UTM Zone 10N

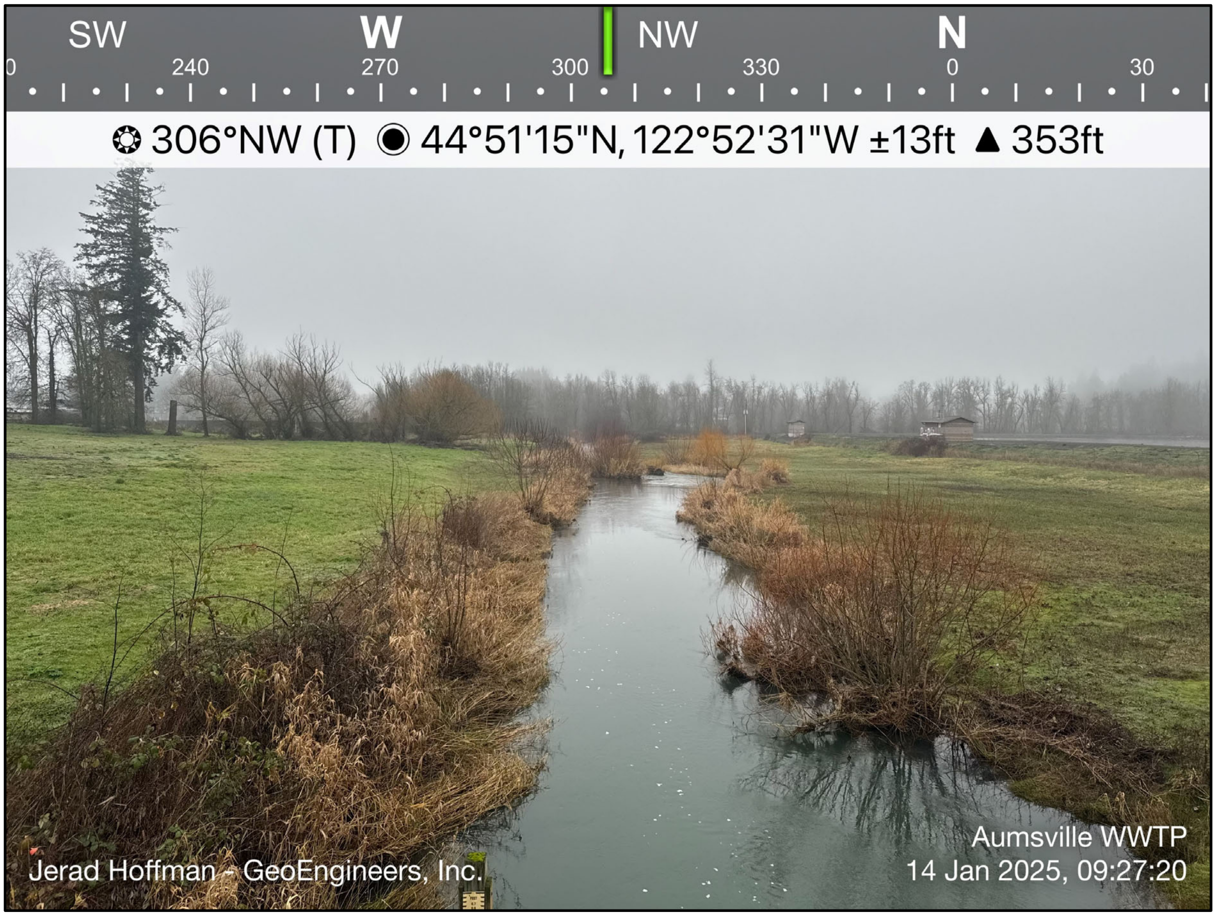
Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation 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

City of Aumsville WWTP Improvements
SBR Discharge Pipe Horizontal Bore Design
Aumsville, Oregon

GeoEngineers

Figure 1



Photograph 1. Site conditions looking northwest along Beaver Creek at the proposed crossing.

City of Aumsville Site Photographs	
City of Aumsville WWTP Improvements SBR Discharge Pipe Horizontal Bore Design Aumsville, Oregon	
GEOENGINEERS	**Figure 2**

15356-003-01 Date Exported 05/20/2026

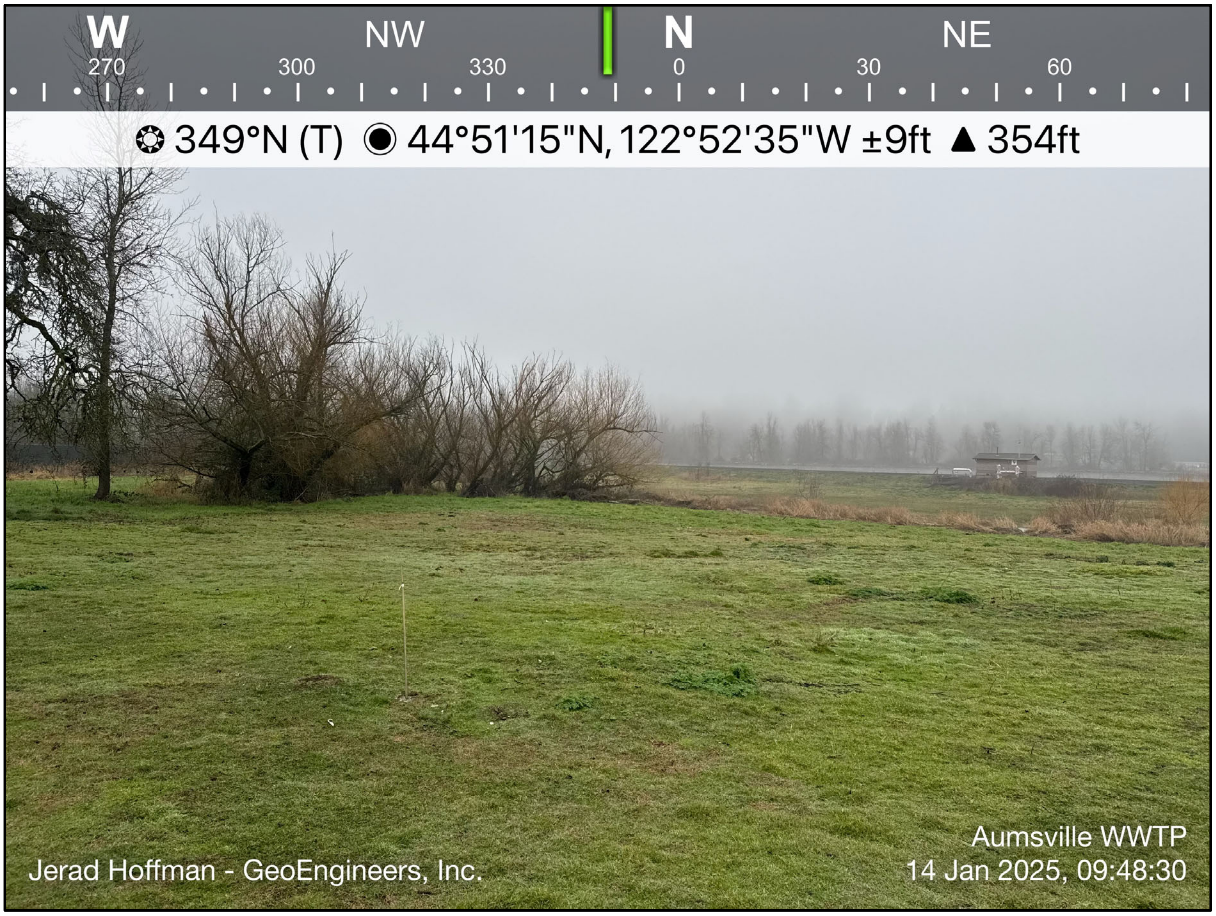
Photograph 3. Site conditions looking southwest toward the proposed auger bore receiving workspace.

City of Aumsville
Site Photographs

City of Aumsville WWTP Improvements
SBR Discharge Pipe Horizontal Bore Design
Aumsville, Oregon

GEOENGINEERS

Figure 3



Photograph 4. Site conditions looking north toward the proposed auger bore launching workspace.

City of Aumsville
Site Photographs

City of Aumsville WWTP Improvements
SBR Discharge Pipe Horizontal Bore Design
Aumsville, Oregon

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Figure 4

TUNNELMAN'S GROUND CLASSIFICATION FOR SOILS

CLASSIFICATION		BEHAVIOR	TYPICAL SOIL TYPES
FIRM		Heading can be advanced without initial support and final lining can be constructed before ground starts to move	Loess above water table; hard clay, marl, cemented sand and gravel when not highly overstressed
RAVELING	SLOW RAVELING FAST RAVELING	Chunks or flakes of material begin to drop out of the arch or walls sometime after the ground has been exposed due to loosening or to overstress and "brittle" fracture (ground separates or brakes along distinct surfaces, opposed to squeezing ground). In fast raveling ground, the process starts within a few minutes, otherwise the ground is slow raveling	Residual soils or sand with small amounts of binder may be fast raveling below the water table, slow raveling above. Stiff fissured clays may be slow or fast raveling depending upon degree of overstress
SQUEEZING		Ground squeezes or extrudes plastically into tunnel, without visible fracturing or loss of continuity, and without perceptible increase in water content. Ductile, plastic yield and flow due to overstress	Ground with low frictional strength. Rate of squeeze depends on degree of overstress. Occurs at shallow to medium depth in clay of very soft to medium consistency. Stiff to hard clay under high cover may move in combination of raveling at excavation surface and squeezing at depth behind surface.
RUNNING	COHESIVE, RUNNING RUNNING	Granular materials without cohesion are unstable at a slope grater than their angle of repose (+/-30-35). When exposed at steeper slopes they run like granulated sugar or dune sand until the slope flattens to the angle of repose.	Clean, dry granular materials. Apparent cohesion in moist sand, or weak cementation in any granular soil may allow the material to stand for brief period of raveling before it breaks down and runs. Such behavior is cohesive-running
FLOWING		A mixture of soil and water flows into the tunnel like a viscous fluid. The material can enter the tunnel from the invert as well as from the face, crown, and walls, and can flow for great distances, completely filling the tunnel in some cases.	Below the water table in silt, sand, or gravel without enough clay content to give significant cohesion and plasticity. May also occur in highly sensitive clay when such material is disturbed.
SWELLING		Ground absorbs water, increases in volume, and expands slowly into the tunnel	Highly preconsolidated clay with plasticity index in excess of about 30, generally containing significant percentages of montmorillonite.

Reference: Heuer, R.E., 1974, Important ground parameters in soft ground tunneling, Subsurface exploration for underground excavation and heavy construction, new England College, Henniker, new Hampshire, American Society of Civil Engineers, New Your, P. 41-55.

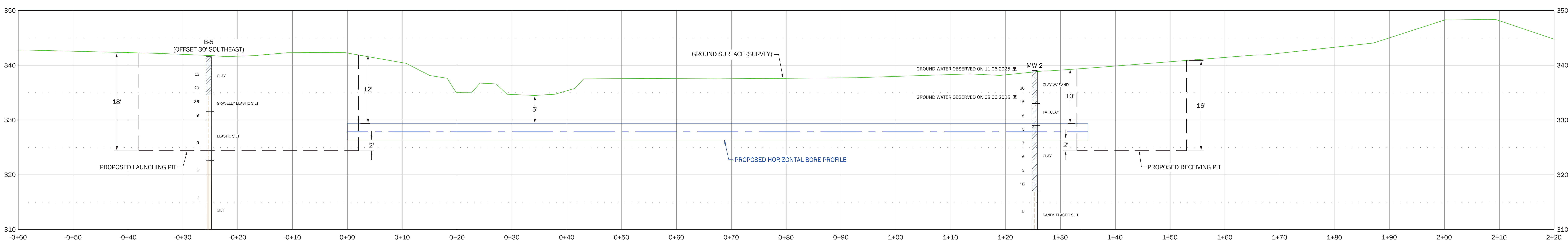
Tunnelman's Ground Classification	
GEOENGINEERS	Figure 5

Appendices

Appendix A
Horizontal Bore Design Drawing

PLAN

10 0 10
SCALE IN FEET



PROFILE

10 0 10
HORIZONTAL SCALE IN FEET
10 0 10
VERTICAL SCALE IN FEET

LEGEND

GROUND WATER OBSERVED
SPT N
TYPE OF SOIL
BORING LOCATION
PROPOSED SBR DISCHARGE ALIGNMENT
PROPOSED NON-POTABLE WATER PIPELINE ALIGNMENT
SANITARY SEWER
POWER LINE
ABANDONED POWER LINE
IRRIGATION LINE
SANITARY SEWER MANHOLE
FENCE
EDGE OF WATER
WETLAND
FLOOD - INUNDATION BOUNDARY (500 YEAR)

CONTRACTOR NOTES:

1. CONTRACTOR SHALL ADHERE TO THE SPECIFICATIONS AND PROJECT REQUIREMENTS PER CITY OF AUMSVILLE SPECIFICATIONS, CONTRACT DOCUMENTS AND SPECIAL PERMIT CONDITIONS, EXCEPT AS NOTED ON THIS DRAWING.
2. CONTRACTOR IS RESPONSIBLE FOR CALLING OREGON STATE ONE-CALL AND LOCATING ALL UNDERGROUND UTILITIES PRIOR TO BEGINNING CONSTRUCTION. IF ANY UTILITY CONFLICT IS IDENTIFIED, CONTRACTOR SHALL SUBMIT PLAN TO AVOID THE UTILITY CONFLICT AND OBTAIN APPROVAL FROM CITY OF AUMSVILLE PRIOR TO INITIATING BORING OPERATIONS.
3. CONTRACTOR IS RESPONSIBLE FOR IDENTIFYING AND PROTECTING ANY FOREIGN UTILITY THAT MAY BE AFFECTED BY THE BORING OPERATIONS.
4. CONTRACTOR IS RESPONSIBLE FOR CONTROLLING GROUNDWATER AND IMPLEMENTING DEWATERING MEASURES IF ENCOUNTERED IN BORE PITS. GROUNDWATER ELEVATION WILL VARY SEASONALLY.
5. CONTRACTOR IS RESPONSIBLE FOR THE CONSTRUCTION PROCESS AND SAFETY, INCLUDING CONSTRUCTION SEQUENCE, TEMPORARY HANDRAILS OR BARRIERS, EXCAVATION ACCESS/EGRESS, LIFTING OF MATERIALS AND EQUIPMENT INTO AND OUT OF TEMPORARY EXCAVATIONS, TEMPORARY SHORING OF EXCAVATIONS, AND STABILITY OF TEMPORARY SLOPES.
6. CONTRACTOR SHALL SUBMIT THE FOLLOWING TO THE OWNER FOR APPROVAL PRIOR TO CONSTRUCTION:
   - BORE MACHINE SPECIFICATIONS AND OPERATING MANUAL.
   - LUBRICATING SYSTEM SPECIFICATIONS AND OPERATING MANUAL (IF USED).
   - STEERING SYSTEM SPECIFICATIONS AND MATERIALS (IF USED).
   - SHORING PLAN SEALED BY A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF OREGON.
   - SPOILS MANAGEMENT AND DISPOSAL PLAN.
   - EXCAVATION AND SHORING INSPECTION AND MONITORING PLAN.
   - CONTINGENCY PLAN FOR UNFORESEEN CONDITIONS: OBSTRUCTIONS, DISCOVERED UNMARKED FOREIGN UTILITIES, GROUNDWATER, CONTAMINATED GROUND CONDITIONS, UNSTABLE GROUND CONDITIONS, LOCKED AUGERS AND/OR STUCK CASING, FLOODED CASING AND/OR LAUNCHING PIT, DRIFT OR DIVE OF CASING, SURFACE SETTLEMENT AND/OR HEAVE, AND ANY OTHER CONDITIONS THAT WOULD PREVENT ADVANCEMENT OF THE CASING, HALTING BORING OPERATIONS.
7. TEMPORARY EXCAVATIONS: TEMPORARY EXCAVATIONS SHALL CONFORM TO OSHA CODE OF FEDERAL REGULATIONS STANDARD, AND ANY OTHER LOCAL, STATE, AND FEDERAL REGULATIONS.
8. SITE ACCESS: ALL EQUIPMENT MUST ACCESS THE SITE ALONG THE CONSTRUCTION RIGHT-OF-WAY OR FROM ACCESS ROUTES APPROVED BY THE OWNER.
9. CONSTRUCTION WORKSPACES: MAXIMUM WORKSPACE LIMITS ARE DEPICTED. RESTRICT CLEARING TO THE WORKSPACE INDICATED SURROUNDING THE LAUNCHING AND RECEIVING PITS ALONG THE CONSTRUCTION RIGHT-OF-WAY.
10. LAUNCHING AND RECEIVING PIT DIMENSIONS WERE LAID OUT TO DEPICT MAXIMUM ANTICIPATED SIZES. ACTUAL SIZE AND ELEVATION DIMENSIONS WILL VERY DEPENDING ON THE NEEDS OF THE SELECTED CONTRACTOR AND PERMIT CONDITIONS.
11. ANNULAR OVERCUT: OVERCUT SHALL NOT EXCEED ½-INCH RADIALLY.
12. LINE AND GRADE: LINE AND GRADE SHALL BE WITHIN 1 PERCENT OF THE BORE LENGTH VERTICALLY AND 2 PERCENT OF THE BORE LENGTH HORIZONTALLY OF THE DESIGNED PROFILE AND ALIGNMENT.
13. SPILL PREVENTION: REFUELING OF ALL CONSTRUCTION EQUIPMENT SHALL BE COMPLETED IN ACCORDANCE WITH THE SPILL PREVENTION, CONTROL, AND COUNTERMEASURE PLAN.
14. EROSION CONTROL: CONTRACTOR SHALL SUPPLY, INSTALL AND MAINTAIN SEDIMENT CONTROL STRUCTURES IN ACCORDANCE WITH CONTRACT DOCUMENTS. CONTRACTOR SHALL INSTALL ADDITIONAL EROSION CONTROL STRUCTURES AS DIRECTED BY THE ENVIRONMENTAL INSPECTOR.
15. SITE RESTORATION: ALL DISTURBED AREAS SHALL BE RETURNED TO THE ORIGINAL CONTOURS. DISTURBED AREAS SHALL BE SEEDED OR SURFACED AS SPECIFIED ON CIVIL SHEETS.
16. THESE STANDARDS AND MINIMUM REQUIREMENTS SHALL APPLY UNLESS OVERRIDDEN BY MORE STRINGENT LOCAL, STATE, OR FEDERAL STANDARDS REQUIREMENTS, OR PERMIT CONDITIONS.

REFERENCES:

1. GEOTECHNICAL DATA: THE GEOTECHNICAL INFORMATION PROVIDED ON THIS DRAWING HAS BEEN GENERALIZED. REFER TO THE BORING LOGS IN THE GEOTECHNICAL REPORT IN THE CONTRACT DOCUMENTS FOR MORE DETAILED INFORMATION.
2. GROUND SURFACE SURVEY AND UTILITIES SHOWN ON THE DRAWING ARE BASED ON SURVEY DATA PROVIDED BY CITY OF AUMSVILLE BY EMAIL ON MAY 30, 2025.

CASING SPECIFICATIONS:

1. CASING WILL CONSIST OF 36" O.D. X 0.500" W.T., MINIMUM STEEL GRADE B BARE.

GEOENGINEERS

5/19/2026 2:05:06 PM
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NO.	DATE	DESCRIPTION	BY
		REVISIONS	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. JAH
DRN. BTL
CKD. BCR
DATE: MAY. 2026

REGISTERED PROFESSIONAL ENGINEER
86240PE
Jerad Hoffman
OREGON
JUN 30, 2017
JERAD A. HOFFMAN
EXPIRES: June 30, 2027
Digitally signed by Jerad Hoffman
Date: 2026.05.19 16:01:25 -07'00'

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF AUMSVILLE, OREGON
WASTEWATER TREATMENT PLANT IMPROVEMENTS

SBR DISCHARGE PIPE HORIZONTAL BORE PLAN AND PROFILE

DRAWING
C118

JOB NUMBER
2599.3210.0

Appendix B
Cased Bore Best Management Practices

Appendix B
Horizontal Bore Best Management Practices

GENERAL

The chosen Bore Contractor should follow industry standard bore construction BMPs. The purpose of this appendix is to summarize typical cased bore construction BMPs and provide BMPs that are recommended by GeoEngineers, Inc. (GeoEngineers) and are in addition to industry standard HDD construction BMPs. The following BMPS do not constitute all bore construction BMPs that are the standard of practice in the cased bore industry.

BORE PLAN CONSIDERATIONS

The chosen Bore Contractor should submit a Bore Plan to ensure that the contract and design requirements are met. The items to be submitted in a Bore Plan are dependent on the specific risk(s) and complexities of the proposed auger bore. Required Bore Plan submittals commonly may include:

- Site Layout Plan
- Casing pipe specifications (diameter, wall thickness, yield strength), manufacturer and certification tests.
- Calculations showing the chosen casing pipe can withstand calculated jacking forces with a suitable factor of safety.
- A description of the jacking thrust resistance system, and supporting documentation and calculations.
- Specification and operating manual of the bore machine.
- Specification and operating manual of the lubrication system.
- Steering system to be used.
- Line and Grade Control Plan.
- A list of workers to be involved with the project, including their respective titles, responsibilities and qualifications. This list would include third-party personnel such as surveyors responsible for settlement monitoring, shoring inspectors, drilling fluid or grouting personnel.
- Launching/receiving pit design, including shoring systems and excavation techniques.
- Shoring design accounting for adjacent surface loading and protection of adjacent structures.
- Shoring Inspection and Monitoring Plan.
- Contingency plans for unanticipated conditions, including obstructions.
- Contingency plan to mitigate settlement during construction.
- Plan for protection of adjacent utilities and structures.
- Dewatering Plan.
- Settlement Monitoring Plan, including location of settlement monitoring points, monitoring schedule and frequency and example settlement monitoring sheets to be included with daily reports.

- Spoils removal (i.e. skid steer, backhoe, crane and bucket, etc.) and management plan.
- Launching/Receiving Pit Backfill Plan.
- Work Safety Plan.
- Example Daily Progress Reports, including machine performance, daily footage, hours worked, volume of soil excavated relative to expected soils for tunnel diameter, settlement monitoring.
- Permits (if obtained by the contractor).
- Excavation techniques.

EXCAVATIONS

Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor and their designated "competent person." All temporary cuts in excess of 4 feet in height should be shored or sloped in accordance with OSHA regulation 1926 Subpart P, Appendix B – Sloping and Benching. For planning purposes, soils in the vicinity of the excavation areas are often assumed to be classified as Type C. Temporary excavations in Type C soil should be inclined no steeper than 1.5H:1V. These allowable cut slope inclinations are applicable to excavations above the groundwater table only. Steeper temporary slope inclinations may be allowed if soil conditions are determined to be suitable by the field geotechnical engineer. For open cuts, we recommend that:

- No traffic, construction equipment, stockpiles or supplies should be allowed within a distance of at least 5 feet from the top of the cut.
- Construction activities should be scheduled to reduce the length of time the cuts are left open.
- Erosion control measures should be implemented as appropriate to limit runoff from the site.
- Surface water should be diverted away from the excavations.

SHORING

Where excavations cannot be sloped to a safe configuration in accordance with OSHA regulations, or because of adjacent structures or utilities, the excavation sidewalls should be supported by shoring systems. Because of the diversity of available shoring systems and construction techniques, the design of temporary shoring is most appropriately left up to the contractor. However, we recommend that the shoring be designed by an engineer licensed in the state in which the work is taking place, and the Professional Engineer-stamped shoring plans and calculations be submitted to the Contractor prior to construction.

Shoring systems may include trench boxes, sheet piles, soldier pile walls or soldier pile/slide rail systems, secant walls or other shoring types. The choice of shoring systems is the responsibility of the contractor and should be based on the depth of the excavations, groundwater conditions, soil conditions, adjacent traffic or structures and other factors. The design of temporary shoring must allow for lateral pressures exerted by the adjacent soil (or embankment), and surcharge loads due to traffic, construction equipment, and temporary stockpiles adjacent to the excavation, etc. The following are typically implemented/considered when selecting and designing the shoring systems:

- At locations where settlement could be detrimental to adjacent structures, existing roads, temporary access roads, utilities, or pavements, the shoring system must be designed to prevent significant lateral movement of the existing soils.
- Precautions must be taken during removal of the shoring or sheeting materials to minimize disturbance of the pipe, underlying bedding materials, natural soils, adjacent structures and utilities.
- If trench boxes are used, they must be of sufficient size, both vertically and horizontally, to support the excavation without excessive deformation of the natural soils.
- The open excavations must be backfilled as soon as practical after the shoring has been removed, or while shoring is being removed if soil conditions warrant to protect adjacent structures and utilities.
- Heavy construction equipment, construction materials, and excavated soil must 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.
- How soil and groundwater conditions may affect stability of the side walls and floor of the excavation.

CASING SELECTION

In pipeline installations where the casing is sacrificial and the carrier pipe will be pulled into the bore as the casing is removed (referred to as a slick bore process), the contractor is responsible for choosing the casing that will be used to complete a cased bore. However, in many cases (particularly municipal projects) the casing diameter, wall thickness and Specified Minimum Yield Strength (SMYS) are required by the contract specifications. In addition, most state and federal transportation agencies and railway owners have established specifications detailing pipe design criteria for trenchless crossings. These specifications should be consulted during selection of the casing.

Where not required by project, regulatory or company specifications, the contractor typically chooses a casing appropriate for the size and type of installation. The selection of the casing diameter, wall thickness and SMYS should be based on soil conditions and the jacking forces required to install the casing, and any regulatory or company specifications. The selected casing and supporting calculations should be incorporated into the contractor's bore plan.

OVERCUTTING

Overcutting is common in most auger bore installations to provide an annular space around the casing, primarily for reducing frictional forces on the casing, and hence the required jacking force to install the casing. Overcutting can be accomplished by using a cutting head outside of the lead section of the casing that is slightly larger than the diameter of the casing. However, in situations where overmining is a concern, banding is the preferred method to create an overcut.

Using a partial or complete band at the head end of the leading casing is common practice when boring in most soil conditions. Banding the casing compacts the soil and creates an overcut that reduces skin friction between the casing and the soil. Banding allows the augers to be nested inside the casing, which can then reduce the risk of overmining, or reduce the risk of groundwater flowing into the casing during auguring. Banding is also beneficial in rocky soils (gravel, cobbles, boulders) in that the band strengthens the leading edge of the casing.

The placement of the banding depends on the contractor's means and methods. However, the band is usually between ⅜ and ½ inch thick and about 6 inches wide, and rolled to fit the casing. The band is usually placed so that it leads the casing by about ½ inch and is welded along the front on the inside of the casing and along the rear on the outside of the casing. The inside chamfer of the front weld can provide a lifting action of the casing if the thrust is rapid, so thrust control by the operator is important to maintain line and grade.

THRUST RESISTANCE

Resistance to anticipated thrust forces is usually accomplished in three ways: using a thrust plate on the back of the launching pit excavation that distributes the jacking force over a large area and uses the passive resistance of the soil in the back of the excavation to derive resisting force; a poured concrete block behind the auger bore machine tracks of sufficient size to resist the estimated jacking force; or anchoring the auger bore machine tracks in the bottom of the excavation or to a concrete slab poured in the bottom of the excavation. In some instances where jacking forces are expected to be very low, the contractor may choose to use friction between the auger bore tracks and the bottom of the excavation or a poured concrete slab.

It is typically the contractor's responsibility to choose the appropriate thrust resistance system primarily because this choice is a matter of means and methods. However, it is important for the contractor to choose the correct thrust resistance system based on soil conditions, launching pit configuration and estimated jacking forces.

LINE AND GRADE CONSIDERATIONS

Line and grade of the bore tracks, and the casing as it is advanced is extremely important, particularly in installations being completed for gravity flow water and sewer installations. Setting up the bore machine tracks on the correct line and grade is a very important first step to controlling line and grade because steering of a bore is very limited and the tracks generally dictate what direction and slope the pipe will be installed. However, once boring commences, the line and grade should be checked upon the addition of each auger flight.

LUBRICATION FLUIDS

Lubrication fluids in bore operations are used to reduce friction between the casing pipe and the surrounding soils, which in-turn reduces jacking forces. Lubricating fluids also reduce the risk of settlement during boring operations, and prior to post-installation grouting (if planned). In sandy soils, lubrication fluids typically consist of bentonite mixed with water. Where moderate to high plasticity clays are anticipated, polymers mixed with other additives are used to reduce the risk of the clays hydrating, swelling or sticking to the pipe and tooling. The selection of the appropriate lubricating fluid depends on site subsurface conditions. The lubrication fluids supplier should be consulted about fluid selection, mixing instructions and concentrations to achieve the proper fluidity and fluid characteristics.

Lubricating fluids should be injected through a series of ports in the casing that are individually piped and connected to a manifold(s) so the lubricating fluid can be directed to individual ports as necessary. The ports and associated piping are installed in the lead section of casing prior to initiating boring operations. As each casing section is added, the lubrication port lines are extended. These ports and manifold(s) can be used later for grouting operations, if necessary.

CARRIER PIPE BLOCKING AND INSIDE ANNULUS GROUTING

Carrier pipes installed inside of a casing may be of any product but typically include PVC, HDPE, concrete and clay pipes. The carrier pipes are most often installed for natural gas or oil pipelines, water pipelines, sewer pipelines, power line conduits and communication line conduits. When line and grade accuracy is required (such as a gravity flow water pipeline), blocking of the carrier pipe in place to avoid flotation and allow for the grade adjustment within the casing is important. Blocking may consist of wood blocking, premanufactured casing spacers or casing insulators. After insertion of the blocked carrier pipe, grout or sand can be pumped into the annular space between the carrier pipe and casing pipe. If sand-cement grout and plastic carrier pipes are used, care must be taken when grouting small pipes in a large casing because the heat of hydration of the sand-cement grout mixture may damage some plastic pipes.

Most grouts are denser than most carrier pipes, and thus floating of the carrier pipe in the grout may occur. In addition, plastic pipes have become lighter over the years, making them more prone to floatation. The risk of floatation can be partially mitigated by blocking as described above. However, lightweight cellular grouts, which have a lower density than sand-cement mixtures, are often the preferred grouting product because they reduce the possibility of floating of the carrier pipe, and they have better fluidity, which allows for low installation pressure. A minimum grout compressive strength of 150 psi is typical in most applications.

When sand is used to fill the inside annulus of the casing, it is important to block the carrier pipe down because sand does not have sufficient strength to prevent the carrier pipe from floating in the casing. This risk is higher with larger diameter pipes. Care should be taken when blowing sand into the casing because it is abrasive and may damage the carrier pipe.

OUTSIDE ANNULUS GROUTING

The annulus between the casing pipe and the surrounding ground should be grouted when crossing sensitive features (nearby utility pipes, highways) and/or where settlement analysis indicates that systematic settlement above the casing pipe could potentially impact the features being crossed. Grout should be injected through a series of ports throughout the entire length of casing that can be individually controlled (similar to described in the lubricating fluids section above) to allow grout to be injected into a pattern that promotes the complete filling of the annulus. A typical grouting pattern begins at the 12-o'clock position and moves towards the 9-o'clock position to allow gravity flow to assist with dispersion of the grout. It is not common to have grout ports below the 9 o'clock position because it is assumed that grout will flow under gravity below the spring line of the casing, and that the casing rests on the bottom of the overcut. Grout port spacing is commonly 5 to 6 feet but should be adjusted based on site conditions. Grouting pressure needs to be closely monitored and controlled to avoid deformation of the casing or movement of ground surface above and around the casing.

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, Inc. (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 Westech Engineering, Inc., the City of Aumsville, Oregon, and their authorized agents. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers, Inc. (GeoEngineers) structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Westech Engineering, Inc. dated January 6, 2025, and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A GEOTECHNICAL ENGINEERING OR ENVIRONMENTAL REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the City of Aumsville, Oregon Wastewater Treatment Plant Improvements project. GeoEngineers considered a number of unique, project-specific factors when establishing the scope

[1] Developed based on material provided by ASFE/The Best People on Earth, Professional Firms Practicing in the Geosciences; www.asfe.org.

of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not 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.

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 subcontractors 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 SUBCONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving subcontractors 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:

1. Advises subcontractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
2. Encourages subcontractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

SUBCONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the subcontractor's procedures, methods, schedule or management of the work site. The subcontractor 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.