Foundation Engineering, Inc.
Professional Geotechnical Services

Memorandum

Date: February 6, 2019

To: Lori Schumacher, P.E.
Civil Engineer II
City of Albany

From: David L. Running, P.E., G.E.
Senior Geotechnical Engineer

Subject: Geotechnical Investigation

Project: Cox Creek Sewer Interceptor
Project 2181105

Expires: 12/31/20

We have completed the requested geotechnical investigation for the above-referenced project. This memorandum includes a description of our work, a discussion of the subsurface conditions, and a summary of laboratory testing.

BACKGROUND

The City of Albany (City) plans to construct a ±6,300-foot long sewer line in three phases extending in its entirety from the City's wastewater treatment plant (WWTP) at 405 Davidson Street NE, south and east to the Albany Municipal Airport, located east of Interstate 5 (I-5). Phase 1 will extend from the City's WWTP to Cox Creek. Phase 2 will extend from Cox Creek to North Shore Drive. Phase 3 will extend from North Shore Drive to the Albany Municipal Airport. The project location and proposed sewer alignment for all phases is shown in Figure 1A (Appendix A).

The sewer line construction in its entirety will include five undercrossings beneath railroad tracks, Salem Avenue, Hwy. 99E/Pacific Blvd., Cox Creek, and I-5. The undercrossing locations are shown on Figure 1A. Pipe depths will range from ±13 to 25 feet. The pipe diameter will be 30 inches from the WWTP to Cox Creek and 24 inches from Cox Creek to the Albany Municipal Airport.

The City is the project owner. The City retained Foundation Engineering, Inc. to complete the geotechnical investigation for the project. Our scope of work was summarized in a proposal dated September 21, 2018, and authorized by the City of Albany Purchase Order No. 0139418, dated October 3, 2018.

FIELD EXPLORATION

We drilled twelve exploratory borings along the planned sewer alignment to characterize the subsurface conditions. The general boring locations are shown on Figure 1A. More detailed boring locations and estimated pipe inlet depths are shown on Figures 2A through 6A (Appendix A). The boring locations shown on the figures are approximate and were based on field measurements using pacing and a steel tape.

BH-1, BH-2, and BH-7 through BH-12 were drilled between October 17 and 19, 2018. The other borings were drilled on December 4 and 5, 2018. The original drilling plan included thirteen borings. BH-6 was eliminated during the field exploration in consultation with the City, based on its close proximity to BH-5 and BH-7 and the similarity of the soil profiles in BH-5 and BH-7. The planned location for BH-6 is shown on Figures 1A and 4A. Table 1 summarizes the drilling locations, ground surface elevations, drilling depths, and drilling dates for each boring.

Table 1. Summary of Borings

Boring	Boring Location	Surface Elevation (ft)	Estimated Pipe Inlet Depth (ft)	Boring Depth (ft)	Date Drilled
BH-1	At the WWTP	±El. 202.5	26	31.5	10/19/18
BH-2	East shoulder of Waverly Drive	±El. 214.0	26	31.5	10/19/18
BH-3	South side of railroad undercrossing, at northeast corner of 3015 Salem Avenue	±El. 214.0	25	31.5	12/5/18
BH-4	South side of Salem Avenue undercrossing, next to the paved path, west of Waverly Lake	±El. 211.0	23	26.5	12/4/18
BH-5	On the paved path west of Waverly Lake, south of BH-4	±El. 210.0	20	26.5	12/4/18
BH-6	On the paved path west of Waverly Lake, south of BH-5 and north of 99E	–	18	0	n/a
BH-7	North side of the Hwy. 99E undercrossing, south of Waverly Lake	±El. 212.5	22	26.5	10/17/18
BH-8	South side of the Hwy. 99E undercrossing, west of Cox Creek	±El. 209.0	20	26.5	10/17/18
BH-9	West side of the Cox Creek undercrossing	±El. 205.5	15	21.5	10/17/18
BH-10	East side of the Cox Creek undercrossing, adjacent to the paved path	±El. 213.5	24	31.5	10/18/18
BH-11	East shoulder of Bain Street, adjacent to 633 Bain Street	±El. 214.0	21	26.5	10/18/18
BH-12	West side of the I-5 undercrossing, on the north shoulder of North Shore Drive, west of Airport Road	±El. 218.0	22	26.5	10/18/18
BH-13	East side of the I-5 undercrossing, on the east shoulder of Aviation Way	±El. 218.5	20	26.5	12/5/18

The borings extended to depths of ±21.5 to 31.5 feet. The drilling depths were selected by rounding up to the nearest 5-foot interval from the anticipated pipe invert depths provided by the City. The boring locations were not surveyed. Ground elevations at the boring locations were estimated based on topographic data provided by the City. The estimated ground elevations are shown on the logs and should be assumed approximate to the nearest ±0.5 foot.

The borings were drilled using a CME-75 truck-mounted drill rig with hollow-stem auger drilling methods. Disturbed soil samples were obtained in each boring at 2.5-foot intervals. The sampling was completed using a split-spoon sampler in conjunction with the Standard Penetration Test (SPT). The SPT, which is performed each time the sampler is driven, provides an indication of the relative stiffness or density of the foundation soils.

The borings were continuously logged during drilling. The sampling depths and SPT data are summarized on the boring logs. The final logs (Appendix B) were prepared based on a review of the field logs and laboratory test results and an examination of the soil samples in our office.

Upon completion of drilling, the boreholes were backfilled with a combination bentonite chips and native cuttings. The ground surface at the boring locations was restored to match the original conditions as close as practical, including capping the boreholes with asphaltic concrete (AC) cold patch, Quikcrete Portland cement concrete (PCC), soil, gravel, or sod, as appropriate.

SITE CONDITIONS

Surface and Subsurface Conditions

The ground surface conditions along the proposed sewer line alignment varied at each boring location. Brief summaries of the surface and subsurface conditions at each boring location are provided below. More detailed soil descriptions are provided on the boring logs in Appendix B.

- BH-1 was drilled at the WWTP on an access road immediately south of a decommissioned clarifier. The ground surface at the drilling location was relatively flat and paved with AC.

  The pavement consists of ±5 inches of AC over ±8 inches of 1-inch minus crushed rock. The pavement section is underlain by alluvium including medium dense silty gravel to ±7.5 feet, followed by dense to very dense sandy gravel with some silt to ±16.3 feet. Medium dense silty sand was encountered from ±16.3 to 20.5 feet. Very stiff clayey silt with trace to some sand followed from ±20.5 to 31.5 feet (the bottom of the boring).

- BH-2 was drilled on the un-paved east shoulder of Waverly Drive. The ground surface at this location was relatively flat and is surfaced with ±10 inches of loose silty gravel (fill).

The fill is underlain by alluvium including very stiff sandy silt to ±7 feet, followed by very dense silty gravel to ±10 feet and medium dense to very dense sandy gravel with some silt to ±27 feet. Dense silty sand was encountered from ±27 to 29.5 feet, followed by very dense sand to ±31.5 feet (the bottom of the boring).

- BH-3 was drilled in an unpaved parking lot in the northeast corner of the property at 3015 Salem Avenue. This boring is at the south side of the proposed railroad undercrossing. The ground surface is relatively flat and covered with ±14 inches of granular fill comprised of predominantly 1½-inch minus crushed gravel with scattered cobbles.

  The granular fill is underlain by fine-grained fill and topsoil to ±4 feet consisting of medium stiff clay. The fine-grained soil is underlain by alluvium including medium dense silty gravel to ±7.5 feet, followed by medium dense to very dense sandy gravel to ±25 feet and alternating layers of very dense silty and sandy gravel to ±31.5 feet (the bottom of the boring).

- BH-4 was drilled a few feet south of the PCC-paved path that extends along the west side of Waverly Lake, south of Salem Ave. This boring is at the south side of the proposed Salem Avenue undercrossing. The surface of the path is relatively flat. The ground east of the path slopes down to the lake and is vegetated with maintained grass.

  The boring encountered fill and topsoil to ±3.5 feet consisting of medium stiff clayey silt. The fine-grained soil is underlain by alluvium including medium dense to dense sandy gravel with some silt to ±15 feet, followed by medium dense gravelly sand to ±17.5 feet and dense to very dense sandy gravel to ±22 feet. The gravel is underlain by hard clayey silt to ±25.5 feet and hard sandy silt to ±26.5 feet (the bottom of the boring).

- BH-5 was drilled through the PCC-paved path that extends along the west side of Waverly Lake between Salem Avenue and 99E. The surface of the path is relatively flat. The ground east of the path slopes down to the lake and is vegetated with maintained grass.

  The pavement consists of ±9 inches of PCC over a ±1-inch thick leveling course of ¾-inch minus crushed rock. The pavement section is underlain by very stiff sandy silt to ±3.5 feet. The sandy silt may be fill or alluvium or a combination of these materials. The sandy silt is underlain by coarse-grained alluvium including dense to very dense silty gravel to ±10 feet, followed by dense to very dense sandy gravel with some silt to ±22.5. feet. Hard clayey silt with some sand followed from ±26.5 feet (the bottom of the boring).

- BH-7 was drilled on grass immediately north of Hwy. 99E on the north side of the proposed Hwy. 99E undercrossing. The terrain at this location is relatively flat and vegetated with maintained grass.

The boring encountered alluvium including loose to dense sandy gravel with some silt to ±12.5 feet, followed by soft sandy silt to ±14.5 feet. Dense sandy gravel was encountered from ±14.5 to 17 feet, followed by dense sand to ±18.5 feet and dense to very dense sandy gravel to ±26.4 feet (the bottom of the boring).

- BH-8 was drilled south of Hwy. 99E adjacent to a PCC-paved path on the south side of the proposed Hwy. 99E undercrossing. The ground surface at this location slopes down to the southwest and is vegetated with maintained grass.

  The boring encountered fill consisting of very dense silty gravel with scattered organics and concrete debris to ±4 feet and medium stiff to stiff clay with some gravel to ±10.5 feet. The fill is underlain by alluvium including loose gravel and clayey gravel to ±15 feet, followed by very dense sandy gravel to ±17.5 feet and medium dense sandy gravel with some silt to ±23 feet. Hard clayey silt followed to ±26.5 feet (the bottom of the boring).

- BH-9 was drilled on the west side of the planned Cox Creek undercrossing, just downstream of the Swan Lake weir. The boring was located on an unpaved path. The ground surface is relatively flat at the boring location. The ground surface to the east slopes down to the creek and is vegetated with short grass and weeds.

  The boring encountered fill to ±6 feet consisting of medium dense gravel with some silt. The fill is underlain by alluvium including very dense sandy gravel to ±20 feet, followed by dense sand with some silt to ±21.5 feet (the bottom of the boring).

- BH-10 was drilled on the east side of the planned Cox Creek undercrossing, just downstream of the Swan Lake weir. The boring was located in a grassy area a few feet west of a PCC-paved path. The ground surface is relatively flat at the boring location. The ground surface to the west slopes down to the creek and is vegetated with maintained grass.

  The boring encountered fill and fine-grained alluvium to ±6 feet consisting of stiff silt with trace gravel. The fine-grained soil is underlain by coarse-grained alluvium including medium dense to very dense silty gravel to ±15 feet, followed by dense to very dense sandy gravel with trace silt to ±25.5 feet. Very dense silty sand was encountered from ±25.5 to 27.5 feet, followed by very dense sandy gravel to ±30.5 feet. The sandy gravel is underlain by very stiff silt to ±31.5 feet (the bottom of the boring).

- BH-11 was drilled through the AC pavement on the east side of Bain Street, just south of the intersection with Oakwood Avenue.

The pavement consists of ±3 inches of AC over ±4 inches of 1½-inch minus crushed rock. The pavement section is underlain by alluvium including very dense silty gravel with some sand to ±7.5 feet, followed by medium dense to very dense sandy gravel with trace to some silt to ±25.9 feet (the bottom of the boring).

- BH-12 was drilled through AC pavement on the north side of North Shore Drive, just west of the intersection with Airport Road. This boring is on the west side of the proposed I-5 undercrossing.

  The pavement consists of ±4 inches of AC over ±8 inches of 1½ -inch minus crushed rock. The pavement section is underlain by alluvium including very stiff silt to ±5 feet. The silt is underlain by medium dense silty sand to ±7.5 feet and medium dense gravelly sand to ±10 feet. Medium dense sandy gravel was encountered from ±10 to 15 feet, followed by medium dense gravelly sand from ±15 to 17.5 feet, and very dense sandy gravel with trace silt to ±26.5 feet (the bottom of the boring).

- BH-13 was drilled a few feet east of Aviation Way, just south of the entrance gate to the Albany Municipal Airport. This boring is on the east side of the proposed I-5 undercrossing. The ground surface at the boring location was covered in short grass and sloped gently down to the east toward a shallow ditch.

  The boring encountered alluvium including medium stiff silty clay to ±4.5 feet. The fine-grained soil is underlain by medium dense to very dense sandy gravel to ±12.5 feet, followed by medium dense silty gravel to ±15 feet, and medium dense to very dense sandy gravel with some silt to ±26.5 feet (the bottom of the boring).

Ground Water

The use of hollow-stem auger drilling methods allowed measurement of ground water levels at the time of drilling. Ground water was encountered in the borings at depths ranging from ±6 to 20 feet. The measured ground water depths and approximate ground water elevations are summarized in Table 2.

The ground water measurements in October 2018 followed a period of more than 4 months with little or no rain. The measurements in December also followed an extended period of relatively dry weather with notable rainfall limited to an accumulation of ±3 to 4 inches in the two weeks prior to drilling. The weather was dry at the time of the exploration. We anticipate the ground water levels will fluctuate seasonally and will be higher during the wet winter and spring months. The water levels near Cox Creek, Waverly Lake, and Swan Lakes will likely match the water levels in these water bodies because the bottoms of the lakes and the creek bed lie within the gravel stratum.

The measurements indicate relatively uniform ground water levels in the flat terrain between BH-2 and BH-10. The ground water level was lower in BH-1, which was drilled in the lower-lying terrain at the WWTP. The ground water levels were higher in the higher terrain between BH-11 and BH-13. The general trend is ground water levels dipping to the northwest toward the Willamette River. This trend is consistent with our previous observations in the area. We anticipate the local ground water and runoff from seasonal rainfall drains toward the Willamette River.

Table 2. Summary of Ground Water Levels

Boring	Date	Depth to Water (ft)	Water Elevation (ft)
BH-1	10/19/18	±19.5	±El. 183.0
BH-2	10/19/18	±20.0	±El. 194.0
BH-3	12/5/18	±18.0	±El. 196.0
BH-4	12/4/18	±12.5	±El. 198.5
BH-5	12/4/18	±12.5	±El. 197.5
BH-6	n/a	–	–
BH-7	10/17/18	±15.0	±El. 197.5
BH-8	10/17/18	±12.0	±El. 197.0
BH-9	10/17/18	±6.0	±El. 199.5
BH-10	10/18/18	±17.0	±El. 196.5
BH-11	10/18/18	±14.0	±El. 200.0
BH-12	10/18/18	±12.0	±El. 206.0
BH-13	12/5/18	±10.0	±El. 208.5

Note: Ground elevations are based on topographic maps provided by the City of Albany and are approximate only. BH-6 was not drilled so no ground water information is provided for that location.

LABORATORY TESTING

The laboratory testing included moisture contents (ASTM D 2216), Atterberg limits (ASTM D4318), and percent fines determinations (ASTM D 1140). The test results were used to classify the soils and estimate their engineering properties. The moisture contents, Atterberg limits, and percent fines results are summarized in Table 1C (Appendix C). The moisture contents are also included on the boring logs.

DISCUSSION

The field exploration indicates construction of the new sewer line will be in predominantly gravelly soils. The gravelly soils will be highly susceptible to sloughing and caving, particularly where ground water is encountered. Therefore, the contractor will need to take these conditions in account when planning the work.

In our borings, ground water was typically encountered ±7 to 11 feet above the planned pipe invert elevations. Therefore, dewatering should be anticipated along the entire length of the project.

Trenchless undercrossings are planned at five locations. The locations, lengths, and depths are summarized in Table 3. Cross-sections for each of the proposed undercrossing locations are shown on Figures 7A through 12A (Appendix A).

Table 3. Summary of Planned Trenchless Undercrossings

Location	Undercrossing Length (ft)	Pipe Depths (ft)
Railroad Undercrossing	137.5	±19 to 27
Salem Avenue Undercrossing	97.5	±22 to 25
Hwy. 99E/Pacific Blvd. Undercrossing	121.5	±23 to 26
Cox Creek Undercrossing	104.0	±6 to 23
I-5 Undercrossing	334.0	±18 to 25

Note: Pipe depths are approximate and are based on the distance from the ground surface to the bottom of the pipe along the length of the undercrossing.

At all of the undercrossing locations, the soil in the drilling zone is anticipated to consist of predominantly sandy or silty gravel. The gravel stratum also likely includes cobbles and sand lenses. Cobbles are not noted on the boring logs because hollow-stem auger drilling did not allow identification of cobbles based on drilling action. Also, the diameter of the split-spoon sampler did not allow for sampling of cobble-sized materials. With any trenchless method, the drilling will likely be difficult due to the presence of coarse granular soils and ground water.

VARIATIONS OF SUBSURFACE CONDITIONS, USE OF THIS REPORT, AND WARRANTY

This memorandum was prepared for the City of Albany and their design consultants for the Cox Creek Sewer Interceptor project in Albany, Oregon. Information contained herein should not be used for other sites or for unanticipated construction without our written consent.

This memorandum is intended as a data report for the planning and design (by others) of trenching and trenchless construction. Contractors using this information to estimate construction quantities, select equipment, materials, means and methods, and costs do so at their own risk.

Our services do not include any survey or assessment of potential surface contamination or contamination of the soil or ground water by hazardous or toxic materials. We assume those services, if needed, have been completed by others.

It is assumed contractors bidding on this project or using this information to plan, design and construct directional bores are familiar with local soil and ground water conditions. The subsurface profiles should be considered accurate only at individual boring locations. Contractors should clearly understand the discussion of subsurface conditions along the planned sewer line alignment requires extrapolation from widely-spaced borings and the subsurface profiles at the boring locations vary. Therefore, the contractor should expect varying subsurface conditions between borings and along the alignment. In particular, the contractor should anticipate the presence of cobbles within the gravel stratum and be aware of the risks and construction difficulties the cobbles and ground water pose.

Our work was done in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

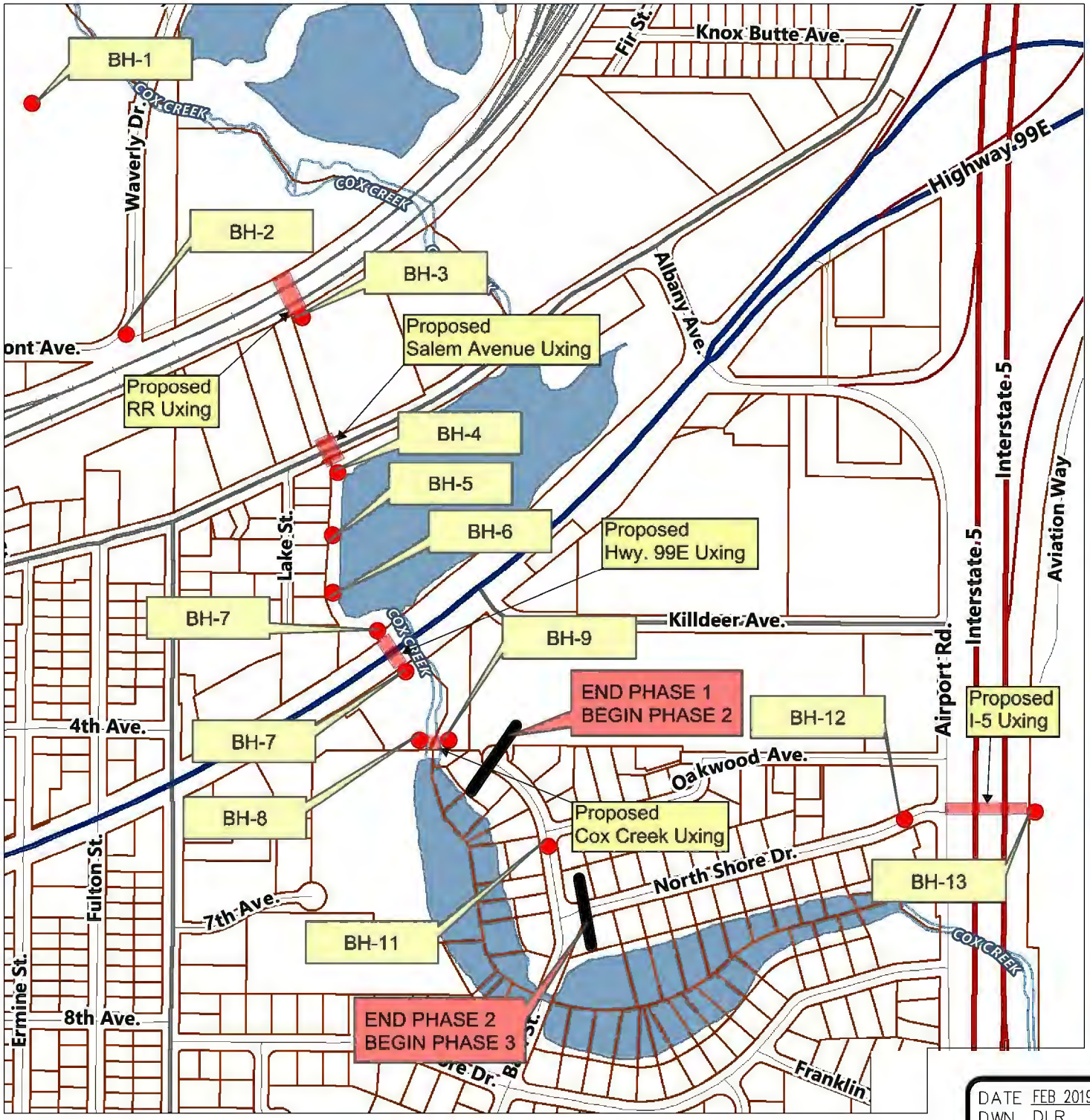
It has been a pleasure assisting you with this phase of your project. Please do not hesitate to contact us if you have any questions or require further assistance.

Attachments

Appendix A

Figures

Foundation Engineering, Inc.
Professional Geotechnical Services



NOTES:
1. BORING LOCATIONS ARE APPROXIMATE.
2. BH-6 WAS NOT DRILLED AND IS SHOWN FOR CLARIFICATION ONLY.
3. SEE REPORT FOR DISCUSSION OF FIELD EXPLORATIONS AND SITE CONDITIONS.
4. BASE MAP PROVIDED BY THE CITY OF ALBANY.

DATE FEB 2019
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PROJECT NO.
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FOUNDATION ENGINEERING INC.
PROFESSIONAL GEOTECHNICAL SERVICES
820 NW CORNELL AVENUE
CORVALLIS, OR 97330-4517
BUS. (541) 757-7645 FAX (541) 757-7650

VICINITY MAP AND BORING LOCATIONS

COX CREEK SEWER INTERCEPTOR
ALBANY, OREGON

FIGURE NO.
1A

FILE NAME: FIG 1A

NOTES:

1. BOREHOLE LOCATIONS WERE ESTABLISHED BY PACING AND ARE APPROXIMATE.
2. DEPTHS SHOWN ARE ANTICIPATED SEWER LINE INLET DEPTHS AT THE BORING LOCATIONS.
3. SEE REPORT FOR A DISCUSSION OF SITE CONDITIONS.
4. BASE IMAGE PROVIDED BY CITY OF ALBANY.

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PROFESSIONAL GEOTECHNICAL SERVICES
820 NW CORNELL AVENUE
CORVALLIS, OR 97330-4517
BUS. (541) 757-7645 FAX (541) 757-7650

SITE LAYOUT AND BORING LOCATIONS
BH-1 AND BH-2
COX CREEK SEWER INTERCEPTOR
ALBANY, OREGON

FIGURE NO.
2A

FILE NAME: FIG 2A

NOTES:

1. BOREHOLE LOCATIONS WERE ESTABLISHED BY PACING AND ARE APPROXIMATE.
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4. BASE IMAGE PROVIDED BY CITY OF ALBANY.

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PROFESSIONAL GEOTECHNICAL SERVICES
820 NW CORNELL AVENUE
CORVALLIS, OR 97330-4517
BUS. (541) 757-7645 FAX (541) 757-7650

SITE LAYOUT AND BORING LOCATIONS
BH-3 AND BH-4
COX CREEK SEWER INTERCEPTOR
ALBANY, OREGON

FIGURE NO.
3A

FILE NAME: FIG 3A

NOTES:

1. BOREHOLE LOCATIONS WERE ESTABLISHED BY PACING AND ARE APPROXIMATE.
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CORVALLIS, OR 97330-4517
BUS. (541) 757-7645 FAX (541) 757-7650

SITE LAYOUT AND BORING LOCATIONS
BH-5 TO BH-10
COX CREEK SEWER INTERCEPTOR
ALBANY, OREGON

FIGURE NO.
4A

FILE NAME: FIG 4A

NOTES:
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PROFESSIONAL GEOTECHNICAL SERVICES
820 NW CORNELL AVENUE
CORVALLIS, OR 97330-4517
BUS. (541) 757-7645 FAX (541) 757-7650

SITE LAYOUT AND BORING LOCATIONS
BH-11
COX CREEK SEWER INTERCEPTOR
ALBANY, OREGON

FIGURE NO.
5A

FILE NAME: FIG 5A

NOTES:

1. BOREHOLE LOCATIONS WERE ESTABLISHED BY PACING AND ARE APPROXIMATE.
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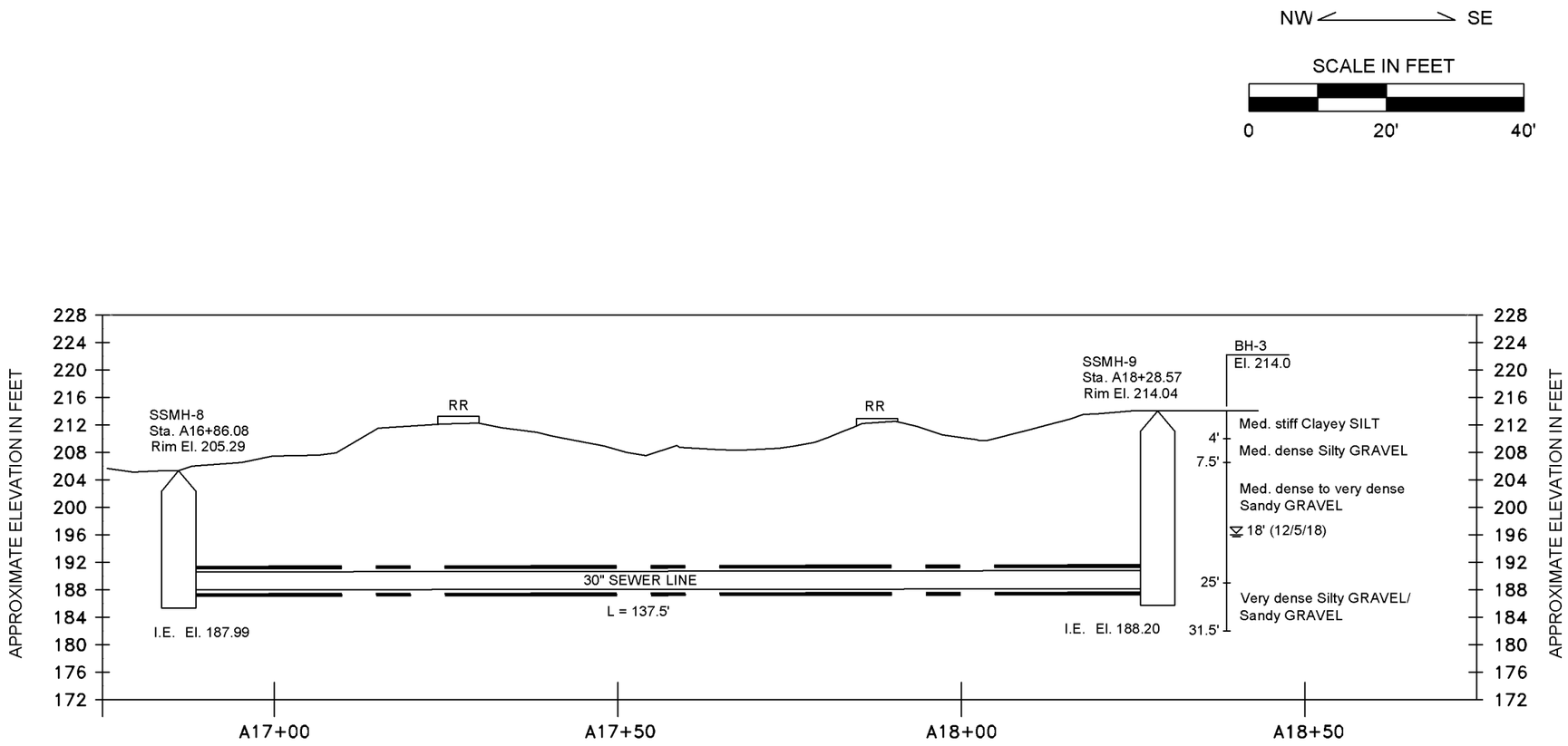
PROFESSIONAL GEOTECHNICAL SERVICES
820 NW CORNELL AVENUE
CORVALLIS, OR 97330-4517
BUS. (541) 757-7645 FAX (541) 757-7650

SITE LAYOUT AND BORING LOCATIONS
BH-12 AND BH-13
COX CREEK SEWER INTERCEPTOR
ALBANY, OREGON

FIGURE NO.
6A

FILE NAME: FIG 6A



NOTES:
1. BASE DRAWING PROVIDED BY CITY OF ALBANY.
2. EXISTING UTILITIES ARE NOT SHOWN.
3. SEE REPORT FOR A DISCUSSION OF SUBSURFACE CONDITIONS.
4. RIM AND INVERT ELEVATIONS ARE APPROSIMATE. SEE CONSTRUCTION DRAWINGS FOR FINAL RIM AND INVERT ELEVATIONS.

FOUNDATION ENGINEERING INC.
PROFESSIONAL GEOTECHNICAL SERVICES
820 NW CORNELL AVENUE
CORVALLIS, OR 97330-4517
BUS. (541) 757-7645 FAX (541) 757-7850

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PROFILE
RAILROAD UNDERCROSSING
COX CREEK SEWER INTERCEPTOR – PHASE 1
ALBANY, OREGON

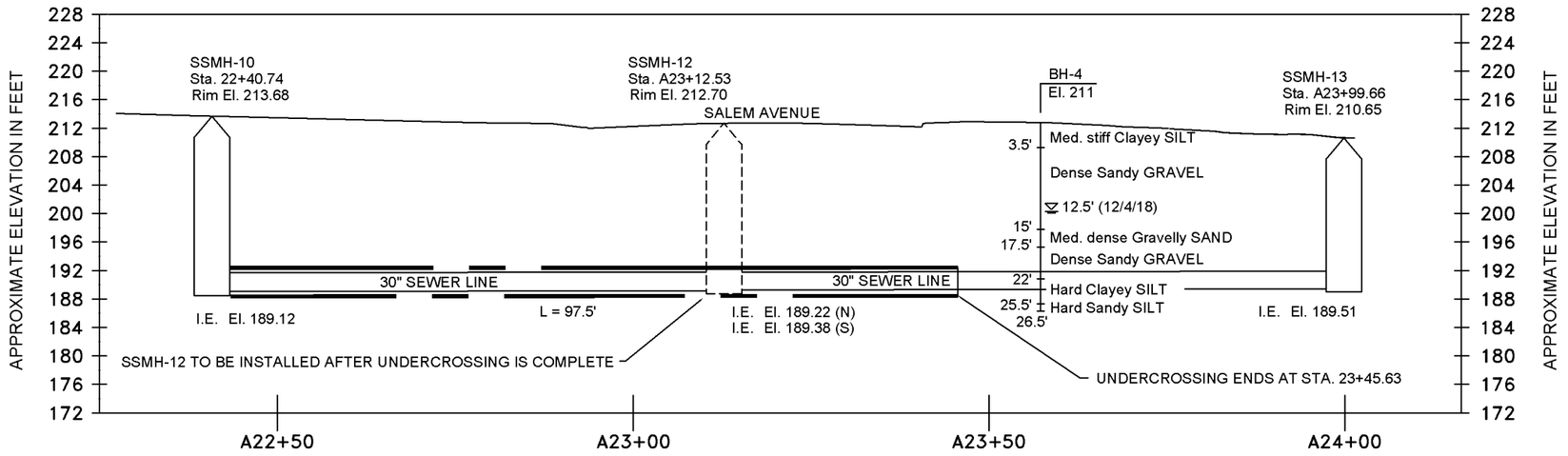
FIGURE NO.
7A

FILE NAME:FIG 7A

N ⟵ ⟶ S

SCALE IN FEET

0 20' 40'



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PROFESSIONAL GEOTECHNICAL SERVICES
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CORVALLIS, OR 97330-4517
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PROFILE
SALEM AVENUE UNDERCROSSING
COX CREEK SEWER INTERCEPTOR – PHASE 1
ALBANY, OREGON

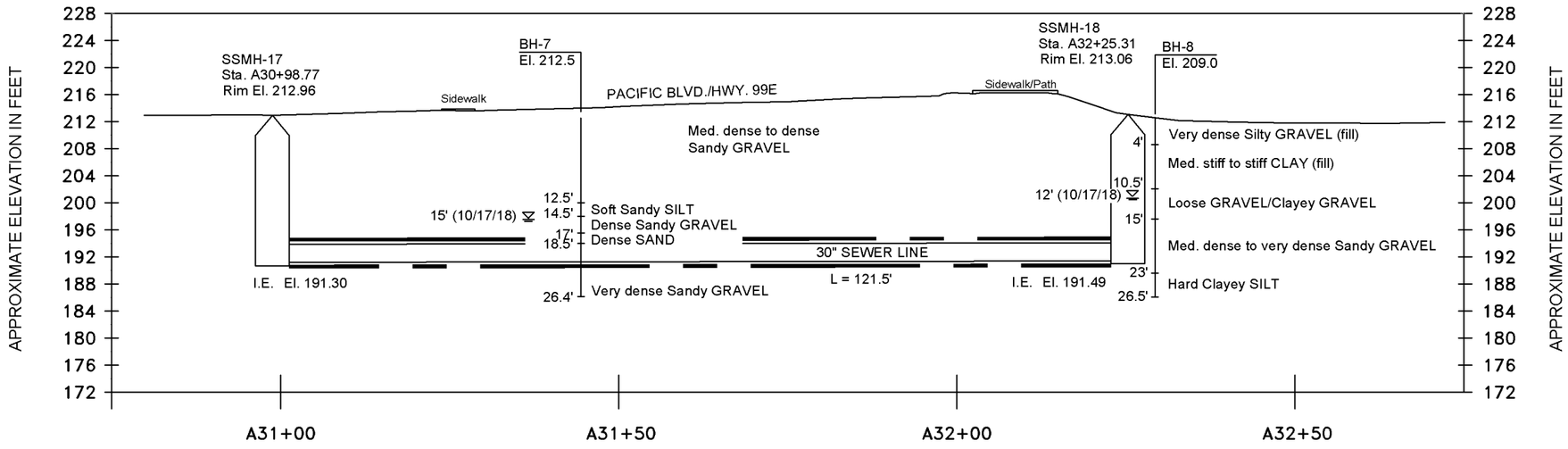
FIGURE NO. 8A

FILE NAME:FIG 8A

NW ⟵ ⟶ SE

SCALE IN FEET

0 20' 40'



D = 22.3'

D = 22.1'

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PROFILE
PACIFIC BLVD./HWY. 99E UNDERCROSSING
COX CREEK SEWER INTERCEPTOR – PHASE 1
ALBANY, OREGON

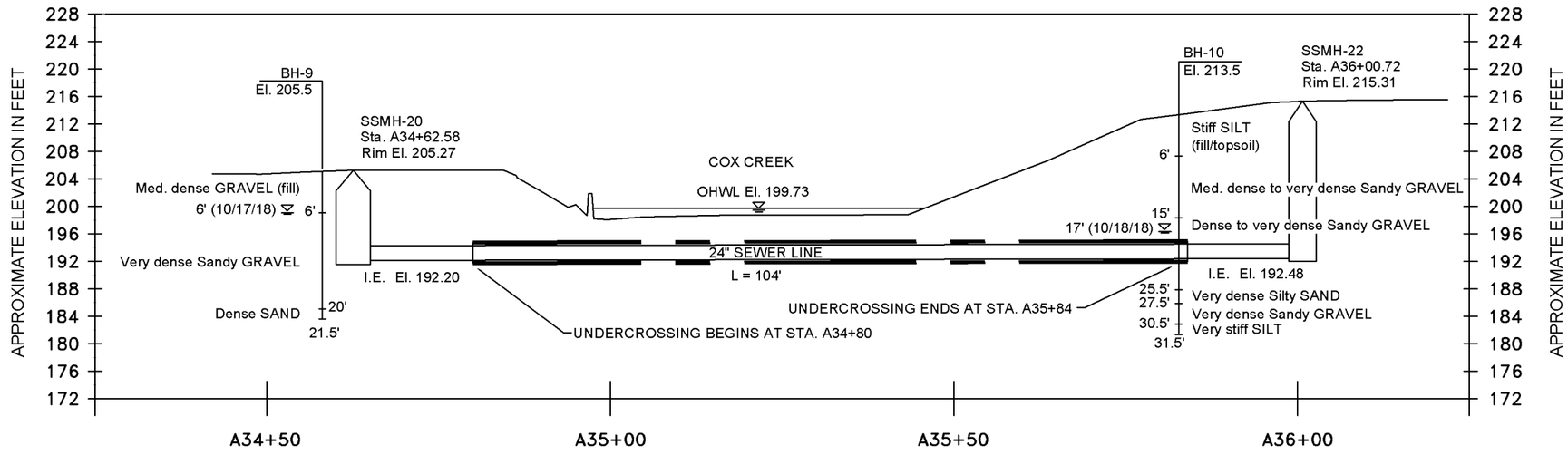
FIGURE NO. **9A**

FILE NAME:FIG 9A

W E

SCALE IN FEET

0 20' 40'



NOTES:
1. BASE DRAWING PROVIDED BY CITY OF ALBANY.
2. EXISTING UTILITIES ARE NOT SHOWN.
3. SEE REPORT FOR A DISCUSSION OF SUBSURFACE CONDITIONS.
4. RIM AND INVERT ELEVATIONS ARE APPROSIMATE. SEE CONSTRUCTION DRAWINGS FOR FINAL RIM AND INVERT ELEVATIONS.

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CORVALLIS, OR 97330-4517
BUS. (541) 757-7645 FAX (541) 757-7850

DATE FEB 2019
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REVIS.
PROJECT NO.
2181105

PROFILE
COX CREEK UNDERCROSSING - PHASE 1
COX CREEK SEWER INTERCEPTOR
ALBANY, OREGON

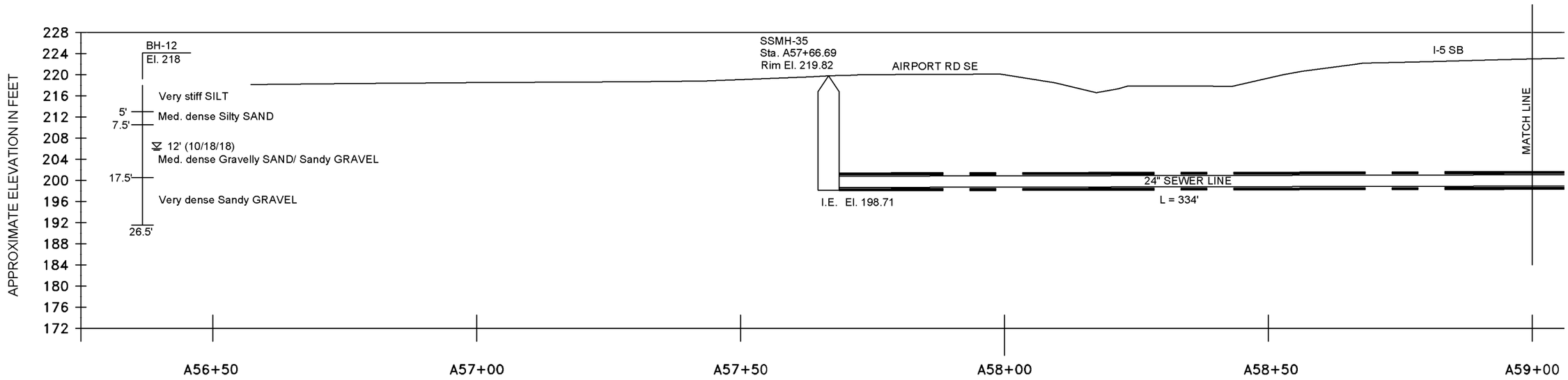
FIGURE NO.
10A

FILE NAME:FIG 10A

W E

SCALE IN FEET

0 20' 40'



NOTES:
1. BASE DRAWING PROVIDED BY CITY OF ALBANY.
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4. RIM AND INVERT ELEVATIONS ARE APPROSIMATE. SEE CONSTRUCTION DRAWINGS FOR FINAL RIM AND INVERT ELEVATIONS.

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CORVALLIS, OR 97330-4517
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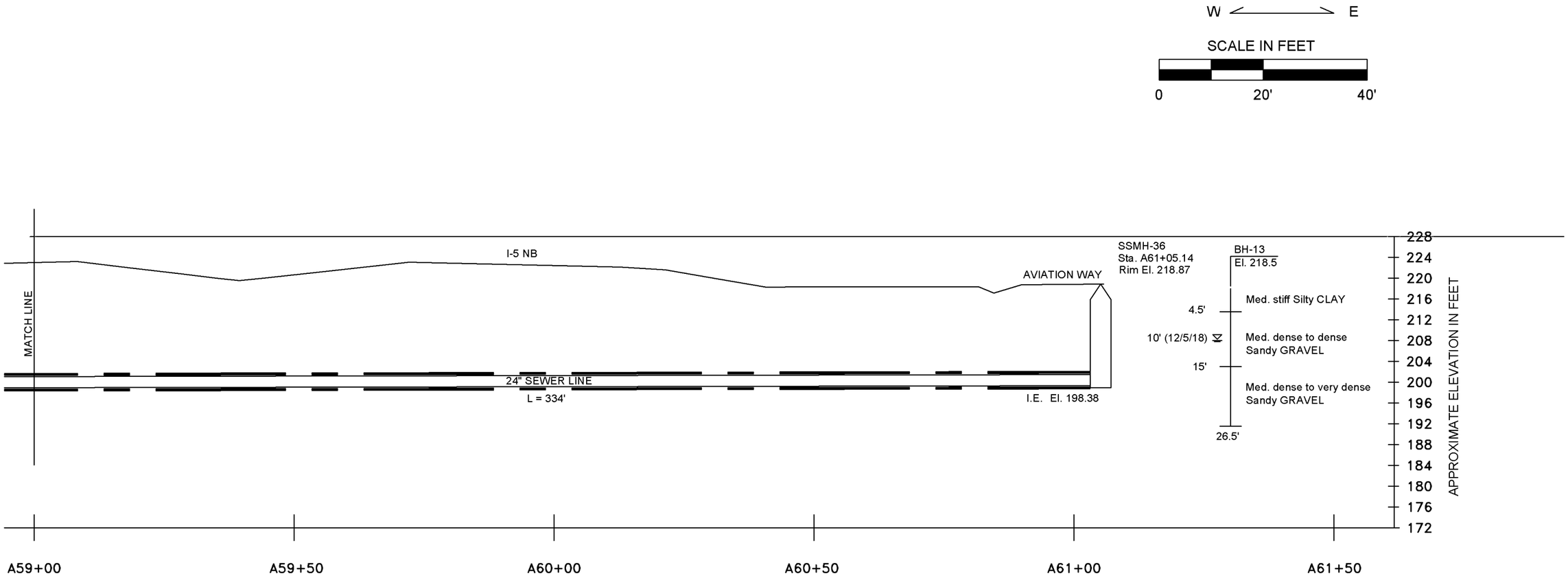
PROFILE
I-5 UNDERCROSSING - WEST SEGMENT
COX CREEK SEWER INTERCEPTOR – PHASE 3
ALBANY, OREGON

FIGURE NO.
11A

FILE NAME:FIG 11A



NOTES:
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2. EXISTING UTILITIES ARE NOT SHOWN.
3. SEE REPORT FOR A DISCUSSION OF SUBSURFACE CONDITIONS.
4. RIM AND INVERT ELEVATIONS ARE APPROSIMATE. SEE CONSTRUCTION DRAWINGS FOR FINAL RIM AND INVERT ELEVATIONS.

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CORVALLIS, OR 97330-4517
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PROFILE
I-5 UNDERCROSSING - EAST SEGMENT
COX CREEK SEWER INTERCEPTOR – PHASE 3
ALBANY, OREGON

FIGURE NO.
12A

FILE NAME:FIG 12A

Appendix B

Boring Logs

Foundation Engineering, Inc.
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DISTINCTION BETWEEN FIELD LOGS AND FINAL LOGS

A field log is prepared for each boring or test pit by our field representative. The log contains information concerning sampling depths and the presence of various materials such as gravel, cobbles, and fill, and observations of ground water. It also contains our interpretation of the soil conditions between samples. The final logs presented in this report represent our interpretation of the contents of the field logs and the results of the sample examinations and laboratory test results. Our recommendations are based on the contents of the final logs and the information contained therein and not on the field logs.

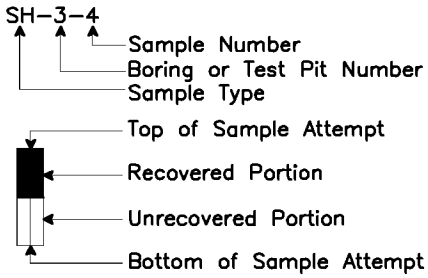
VARIATION IN SOILS BETWEEN TEST PITS AND BORINGS

The final log and related information depict subsurface conditions only at the specific location and on the date indicated. Those using the information contained herein should be aware that soil conditions at other locations or on other dates may differ. Actual foundation or subgrade conditions should be confirmed by us during construction.

TRANSITION BETWEEN SOIL OR ROCK TYPES

The lines designating the interface between soil, fill or rock on the final logs and on subsurface profiles presented in the report are determined by interpolation and are therefore approximate. The transition between the materials may be abrupt or gradual. Only at boring or test pit locations should profiles be considered as reasonably accurate and then only to the degree implied by the notes thereon.

SAMPLE OR TEST SYMBOLS



C – Pavement Core Sample
CS – Rock Core Sample
OS – Oversize Sample (3–inch split–spoon)
S – Grab Sample
SH – Thin–walled Shelby Tube Sample
SS – Standard Penetration Test Sample (split–spoon)

▲ Standard Penetration Test Resistance equals the number of blows a 140 lb. weight falling 30 in. is required to drive a standard split–spoon sampler 1 ft. Practical refusal is equal to 50 or more blows per 6 in. of sampler penetration.

● Water Content (%).

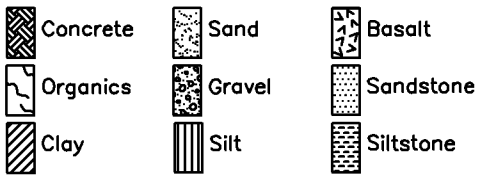
UNIFIED SOIL CLASSIFICATION SYMBOLS

G – Gravel	W – Well Graded
S – Sand	P – Poorly Graded
M – Silt	L – Low Plasticity
C – Clay	H – High Plasticity
Pt – Peat	O – Organic

FIELD SHEAR STRENGTH TEST

Shear strength measurements on test pit side walls, blocks of soil or Shelby tube samples are typically made with Torvane or Field Vane shear devices.

TYPICAL SOIL/ROCK SYMBOLS



WATER TABLE

Water Table Location

(1/31/16) Date of Measurement

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BEAVERTON, OR 97008
BUS. (503) 641–1541

SYMBOL KEY

EXPLORATION LOGS

Explanation of Common Terms Used in Soil Descriptions

Field Identification	Cohesive Soils			Granular Soils	
	SPT*	S_u** (tsf)	Term	SPT*	Term
Easily penetrated several inches by fist.	0 – 2	< 0.125	Very Soft	0 – 4	Very Loose
Easily penetrated several inches by thumb.	2 – 4	0.125–0.25	Soft	4 – 10	Loose
Can be penetrated several inches by thumb with moderate effort.	4 – 8	0.25 – 0.50	Medium Stiff	10 – 30	Medium Dense
Readily indented by thumb but penetrated only with great effort.	8 – 15	0.50 – 1.0	Stiff	30 – 50	Dense
Readily indented by thumbnail.	15 – 30	1.0 – 2.0	Very Stiff	> 50	Very Dense
Indented with difficulty by thumbnail.	>30	> 2.0	Hard		

* SPT N–value in blows per foot (bpf)
** Undrained shear strength

Term	Soil Moisture Field Description
Dry	Absence of moisture. Dusty. Dry to the touch.
Damp	Soil has moisture. Cohesive soils are below plastic limit and usually moldable.
Moist	Grains appear darkened, but no visible water. Silt/clay will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grain surfaces. Sand and cohesionless silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is wetter than the optimum moisture content and above the plastic limit.

Term	PI	Plasticity Field Test
Non–plastic	0 – 3	Cannot be rolled into a thread at any moisture.
Low Plasticity	3 – 15	Can be rolled into a thread with some difficulty.
Medium Plasticity	15 – 30	Easily rolled into thread.
High Plasticity	> 30	Easily rolled and re–rolled into thread.

Term	Soil Structure Criteria
Stratified	Alternating layers at least ¼ inch thick.
Laminated	Alternating layers less than ¼ inch thick.
Fissured	Contains shears and partings along planes of weakness.
Slickensided	Partings appear glossy or striated.
Blocky	Breaks into small lumps that resist further breakdown.
Lensed	Contains pockets of different soils.

Term	Soil Cementation Criteria
Weak	Breaks under light finger pressure.
Moderate	Breaks under hard finger pressure.
Strong	Will not break with finger pressure.

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CORVALLIS, OR 97330
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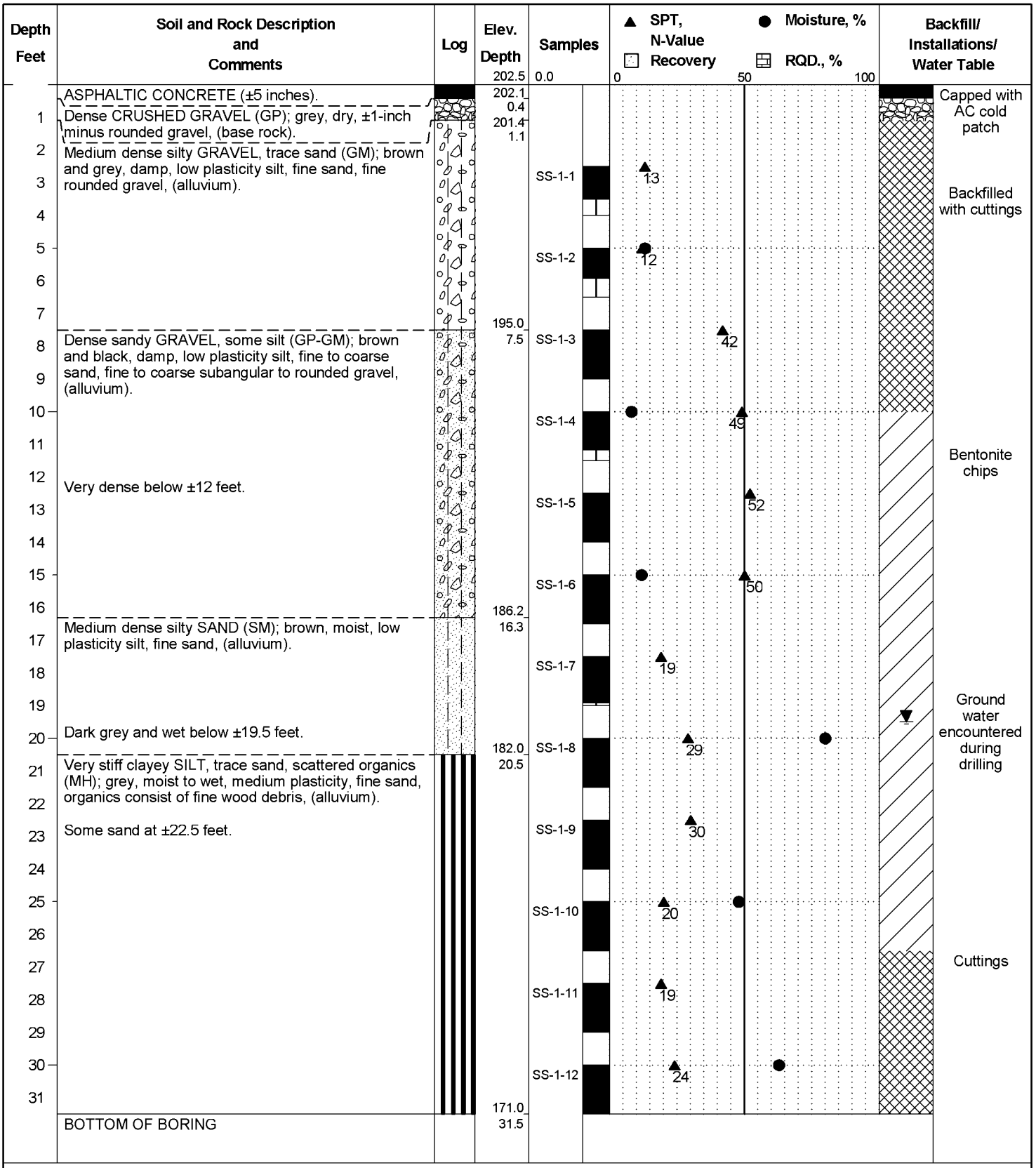
COMMON TERMS

SOIL DESCRIPTIONS



Project No.: 2181105

Surface Elevation: 202.5 feet (Approx.)

Date of Boring: October 19, 2018

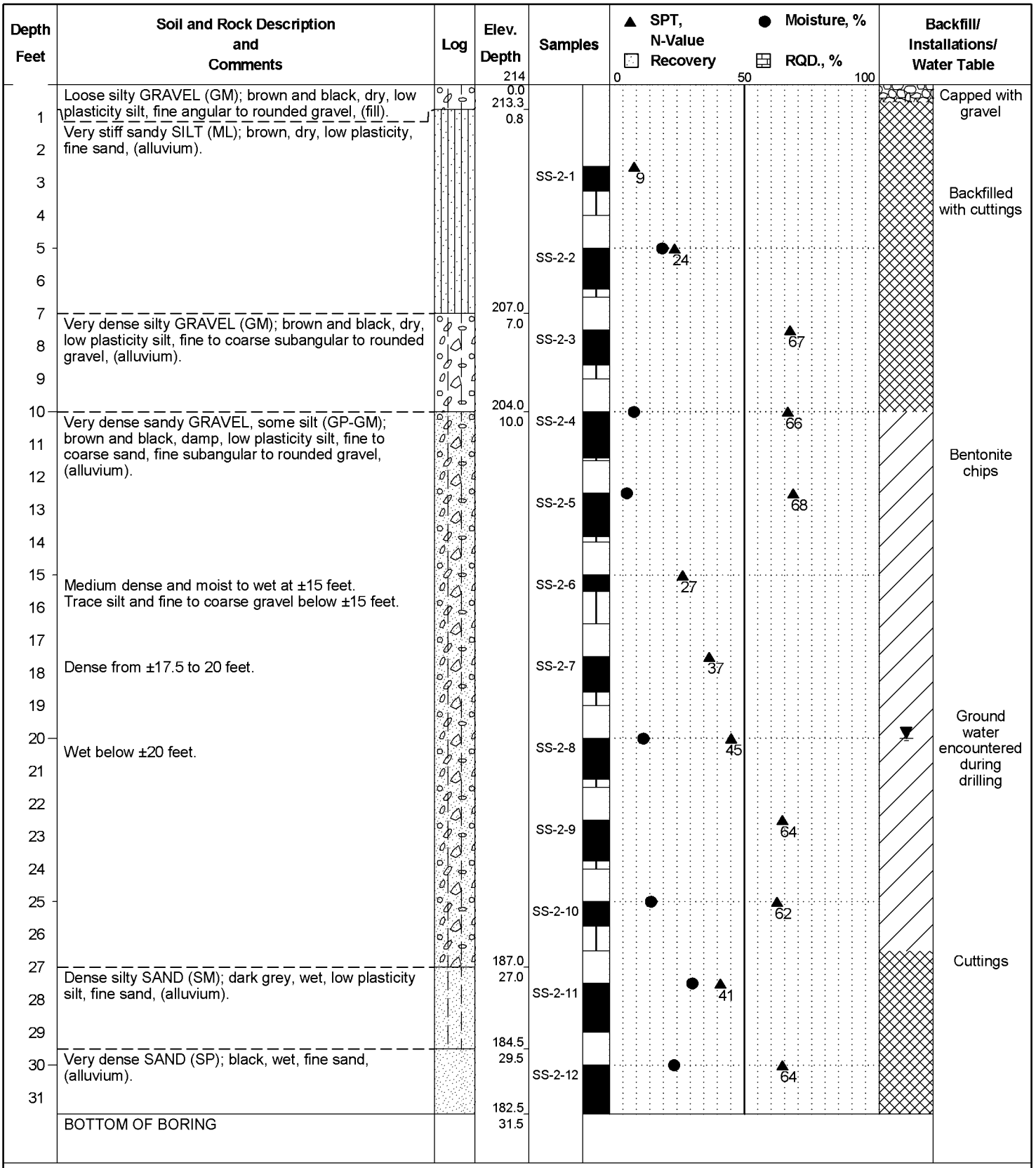
Boring Log: BH- 1

Cox Creek Sewer Interceptor

Albany, Oregon

Foundation Engineering, Inc.

Last edited 1/23/19 mmw



Project No.: 2181105

Surface Elevation: 214.0 feet (Approx.)

Date of Boring: October 19, 2018

Boring Log: BH- 2

Cox Creek Sewer Interceptor

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Depth Feet	Soil and Rock Description and Comments	Elev. Depth 214	Samples	SPT, N-Value / Recovery / Moisture, % / RQD., % (0 – 50 – 100)	Backfill/ Installations/ Water Table
1	Loose to dense CRUSHED GRAVEL, scattered cobbles (GP); grey, moist, ±1½-inch minus subangular to subrounded gravel, cobbles up to ±4 inch diameter, (fill).	0.0			Capped with gravel
2		212.8 1.2			
3	Medium stiff CLAY, scattered organics (CL); grey, moist, medium plasticity, organics consist of fine roots, (topsoil/fill).		SS-3-1	7	Backfilled with cuttings
4		210.0 4.0			
5	Medium dense silty GRAVEL (GM); brown and black, moist, low plasticity silt, fine to coarse subangular to rounded gravel, (alluvium).		SS-3-2	15	
6					
7		206.5			Bentonite chips
8	Dense sandy GRAVEL, some silt (GP-GM); brown and black, moist, low plasticity silt, medium sand, fine to coarse subangular to rounded gravel, (alluvium).	7.5	SS-3-3	46	
9					
10			SS-3-4	49	
11					
12					
13	Fine to coarse sand below ±12.5 feet.		SS-3-5	30	
14					
15	Medium dense at ±15 feet.		SS-3-6	22	
16					
17					
18	Wet below ±18 feet.		SS-3-7	37	Ground water encountered during drilling
19					
20	Very dense below ±20 feet.		SS-3-8	55	
21					
22					
23			SS-3-9	71	
24					
25	Very dense silty GRAVEL, some sand (GM); brown and black and iron-stained, low plasticity, fine to coarse sand, fine to coarse subangular to rounded gravel, (alluvium).	189.0 25.0	SS-3-10	89	
26					
27					
28	Very dense sandy GRAVEL, some silt (GP-GM); brown and black, wet, low plasticity silt, fine to medium sand, fine to coarse subangular to rounded gravel, (alluvium).	186.5 27.5	SS-3-11	50/5"	
29					Cuttings
30		184.0			
31	Very dense silty GRAVEL, some sand (GM); grey, wet, low plasticity silt, fine to medium sand, fine to coarse subangular to rounded gravel, (alluvium).	30.0	SS-3-12	83	
	BOTTOM OF BORING	182.5 31.5			

Project No.: 2181105

Surface Elevation: 214.0 feet (Approx.)

Date of Boring: December 5, 2018

Boring Log: BH- 3

Cox Creek Sewer Interceptor

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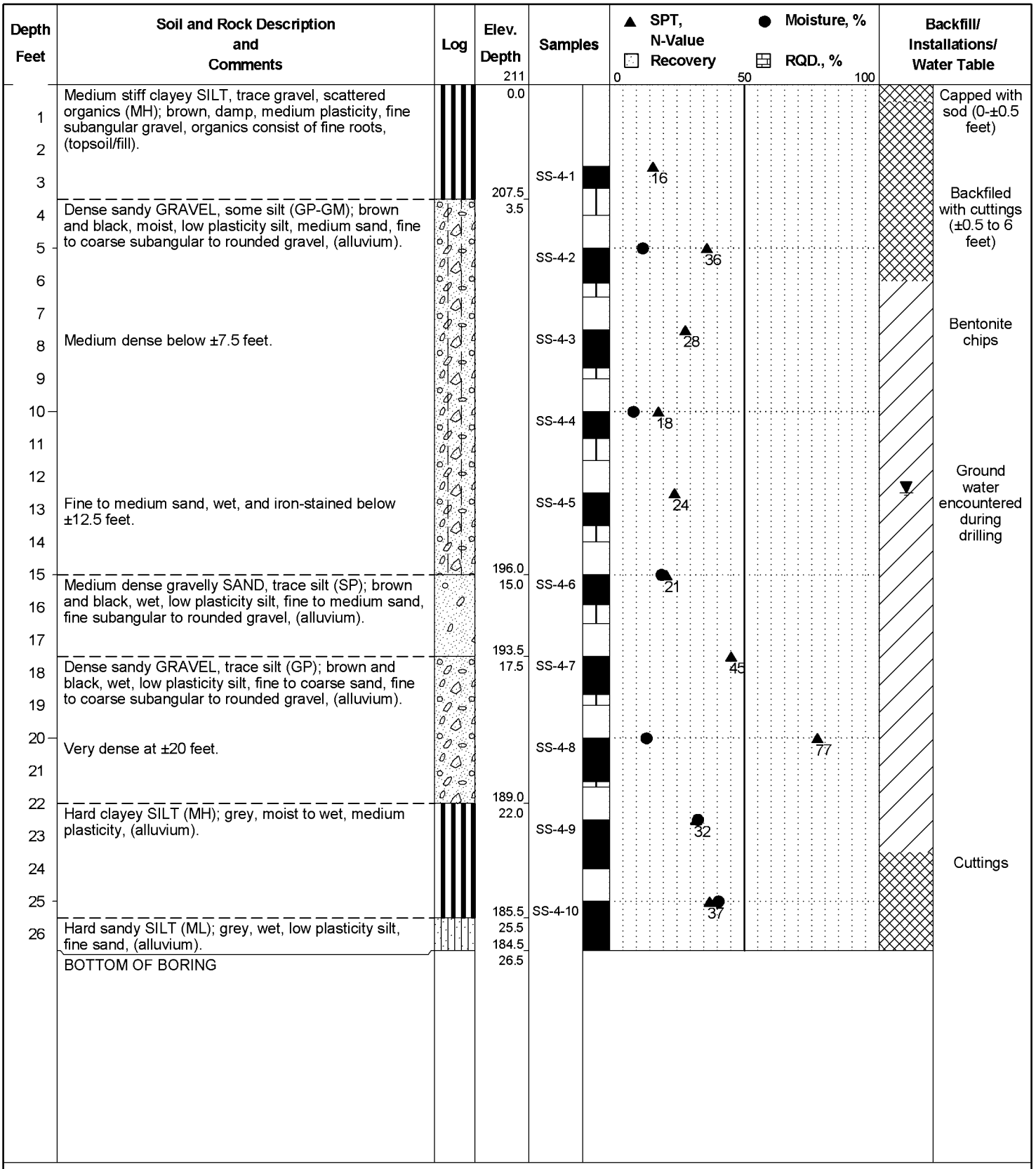

Project No.: 2181105

Surface Elevation: 211.0 feet (Approx.)

Date of Boring: December 4, 2018

Boring Log: BH- 4

Cox Creek Sewer Interceptor

Albany, Oregon

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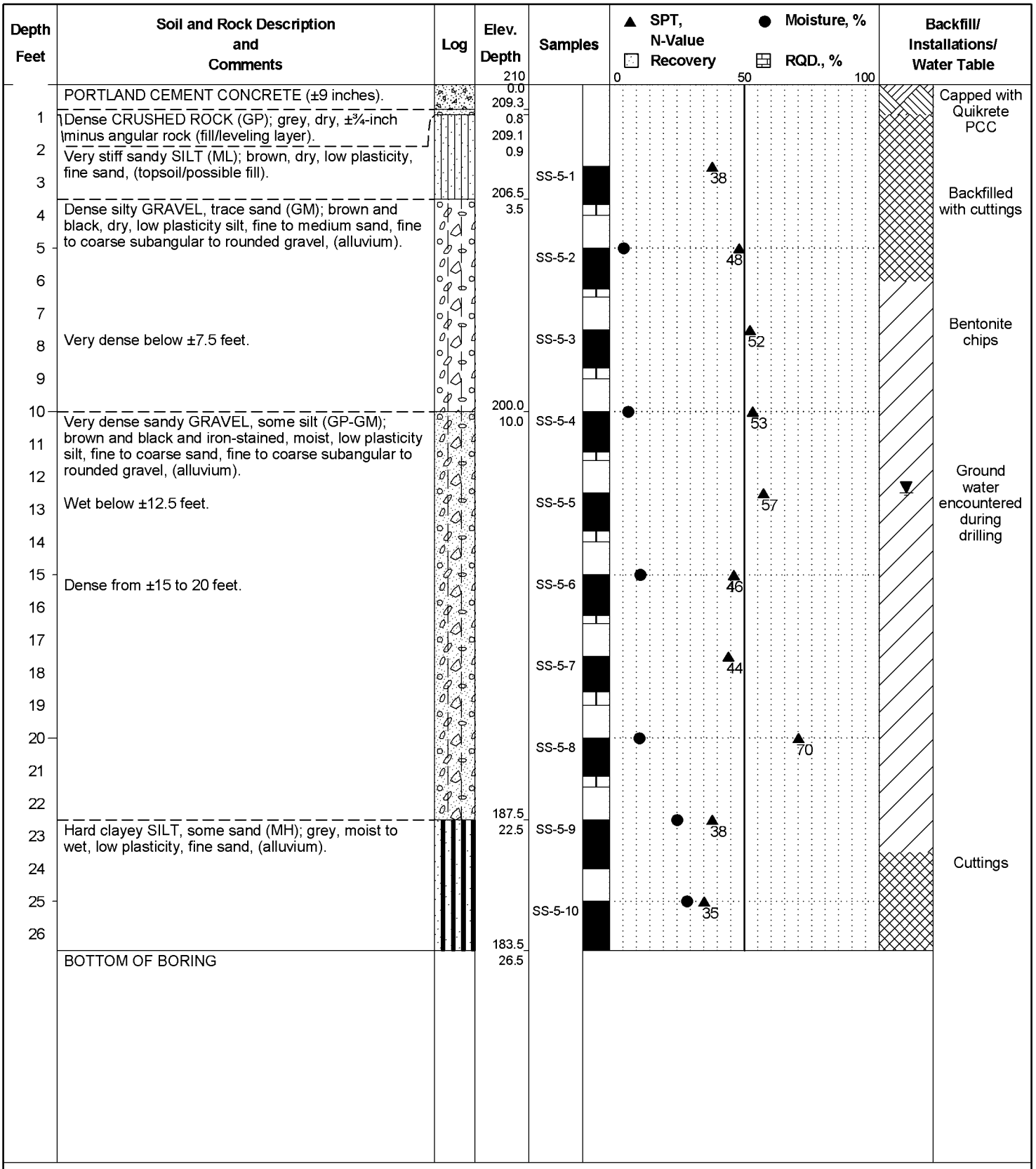
Last edited 1/23/19 mmw



Project No.: 2181105

Surface Elevation: 210.0 feet (Approx.)

Date of Boring: December 4, 2018

Boring Log: BH- 5

Cox Creek Sewer Interceptor

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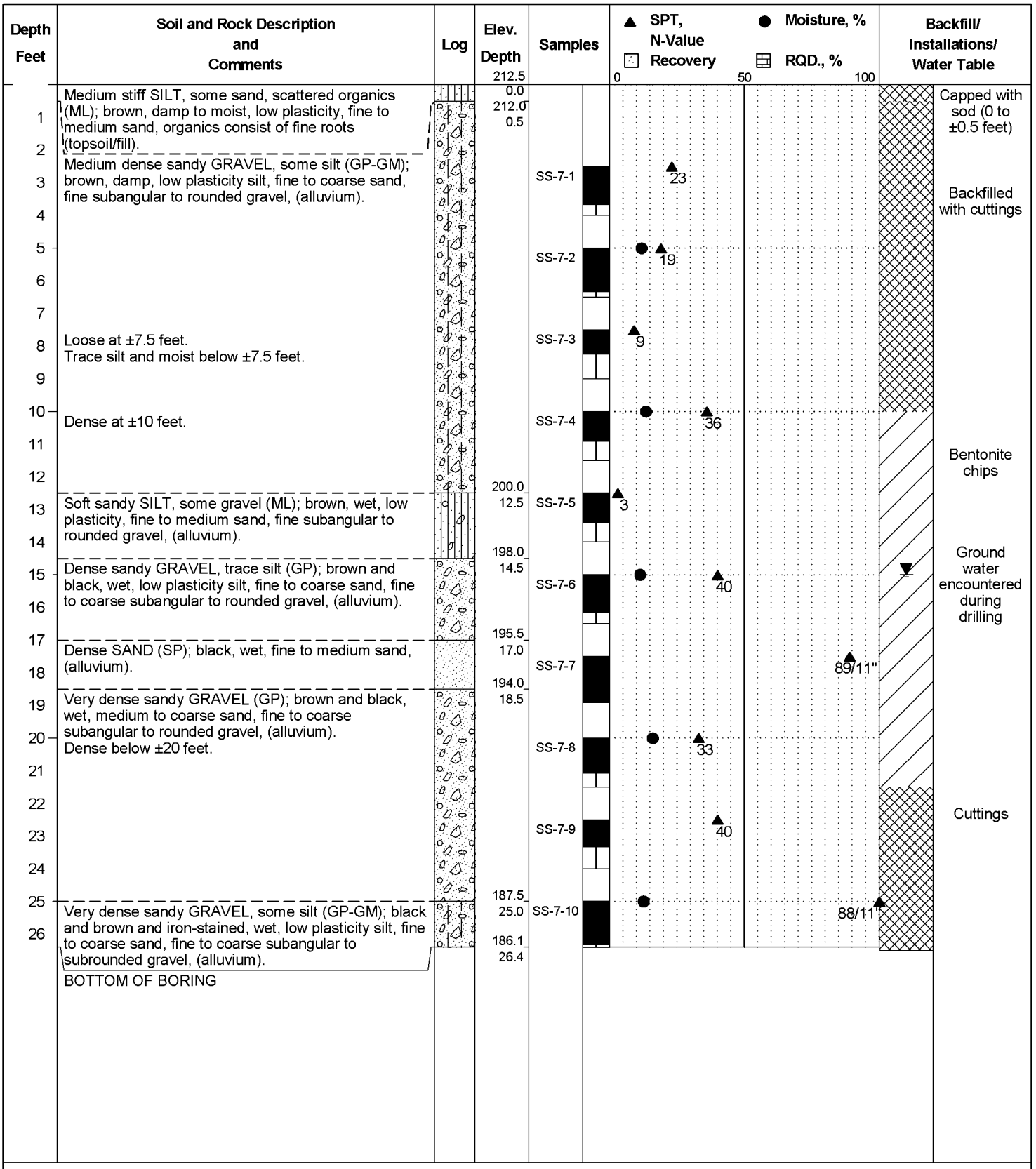

Project No.: 2181105

Surface Elevation: 212.5 feet (Approx.)

Date of Boring: October 17, 2018

Boring Log: BH- 7

Cox Creek Sewer Interceptor

Albany, Oregon

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Depth Feet	Soil and Rock Description and Comments	Elev. Depth (209)	Samples	SPT, N-Value / Recovery / Moisture, % / RQD., % (0–50–100)	Backfill/ Installations/ Water Table
1–4	Very dense silty GRAVEL, scattered organics (GM); brown, dry, low plasticity silt, fine to coarse angular to rounded gravel, organics consist of fine roots and grasses, (fill). Concrete debris (±8 inches thick) at ±1 foot.	0.0	SS-8-1	70	Capped with gravel
		205.0			Backfilled with cuttings
4–10	Medium stiff CLAY, some gravel, trace sand (CL); brown, damp, low plasticity, medium to coarse sand, fine rounded gravel, (fill). Stiff and iron-stained and glass debris at ±7.5 feet.	4.0	SS-8-2	6	
			SS-8-3	9	
		198.5	SS-8-4	7	
10–12	Loose clayey GRAVEL (GC); brown, wet, medium plasticity clay, fine rounded gravel, (alluvium).	10.5			Ground water encountered during drilling
		196.5			
12–15	Loose GRAVEL (GP); grey, wet, fine to coarse angular to rounded gravel, (alluvium).	12.5	SS-8-5	4	
		194.0			
15–17	Very dense sandy GRAVEL (GP); grey, wet, medium sand, fine to coarse subangular to rounded gravel, (alluvium).	15.0	SS-8-6	57	Bentonite chips
		191.5			
17–23	Medium dense sandy GRAVEL, some silt (GP-GM); light brown, wet, low plasticity silt, fine to medium sand, fine subangular to rounded gravel, (alluvium).	17.5	SS-8-7	11	
			SS-8-8	30	
		186.0	SS-8-9	36	Cuttings
23–26	Hard clayey SILT (MH); grey, moist to wet, low plasticity, (alluvium).	23.0			
			SS-8-10	51	
	BOTTOM OF BORING	182.5 / 26.5			

Project No.: 2181105

Surface Elevation: 209.0 feet (Approx.)

Date of Boring: October 17, 2018

Boring Log: BH- 8

Cox Creek Sewer Interceptor

Albany, Oregon

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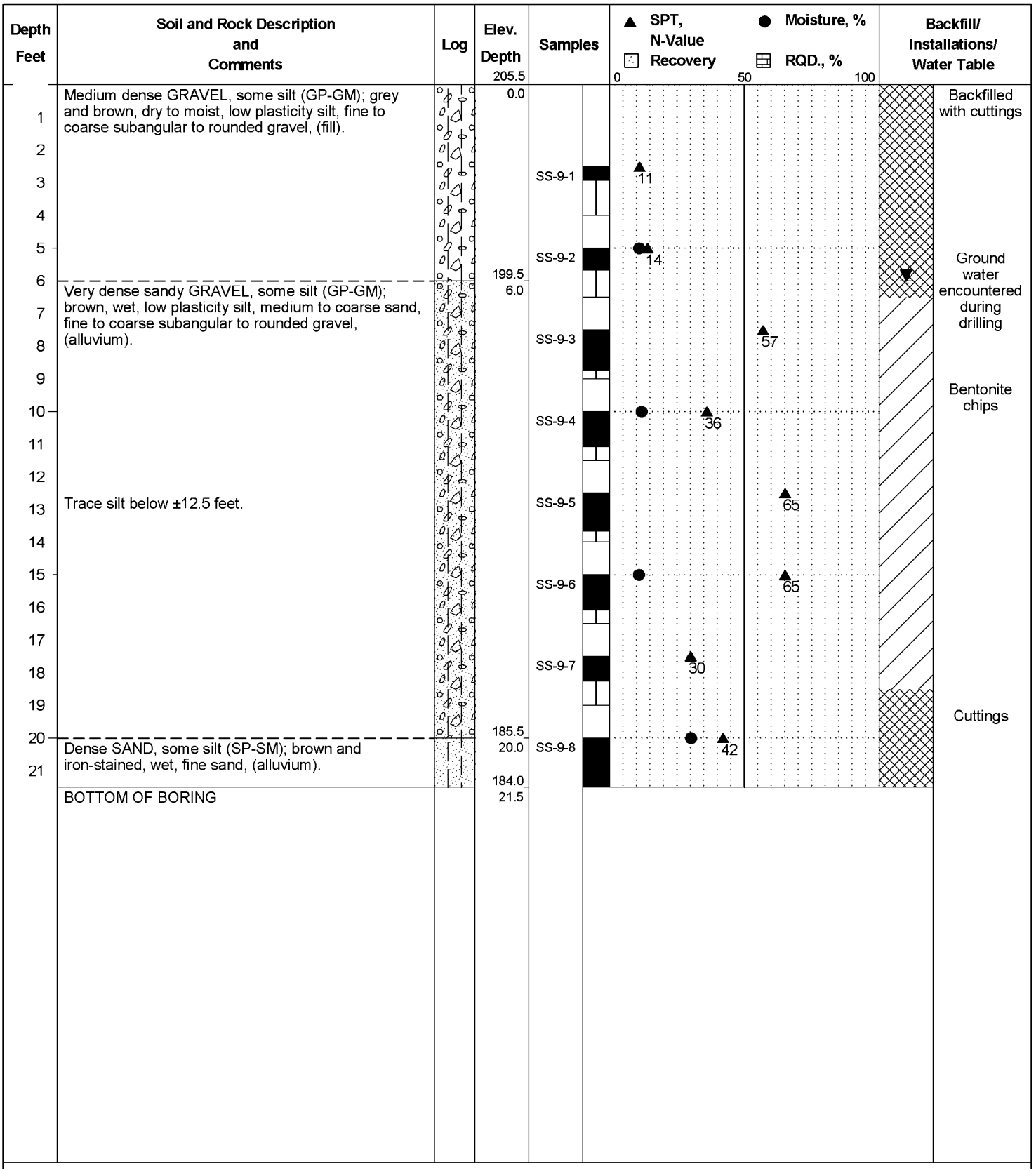

Project No.: 2181105

Surface Elevation: 205.5 feet (Approx.)

Date of Boring: October 17, 2018

Boring Log: BH- 9

Cox Creek Sewer Interceptor

Albany, Oregon

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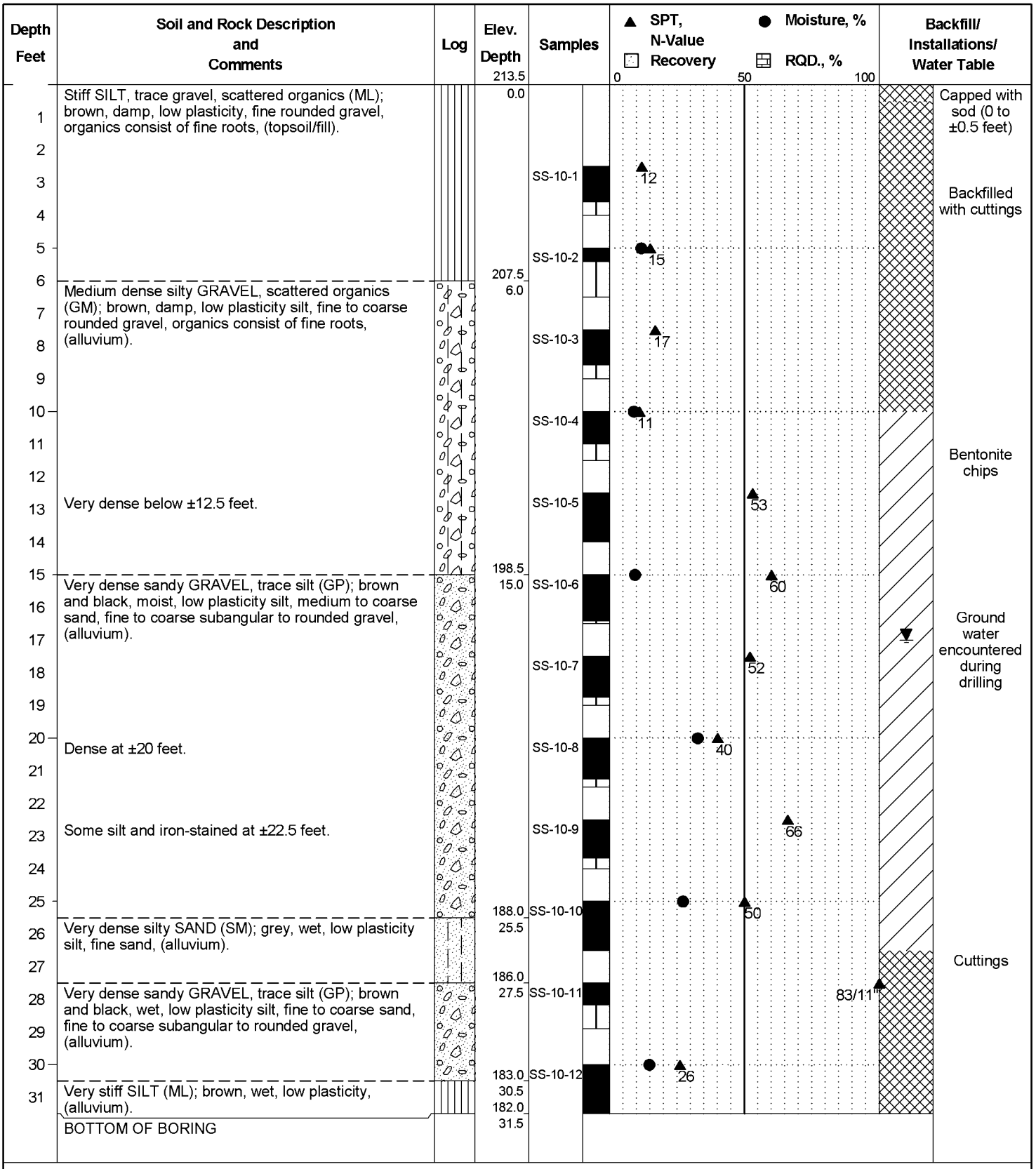

Project No.: 2181105

Surface Elevation: 213.5 feet (Approx.)

Date of Boring: October 18, 2018

Boring Log: BH-10

Cox Creek Sewer Interceptor

Albany, Oregon

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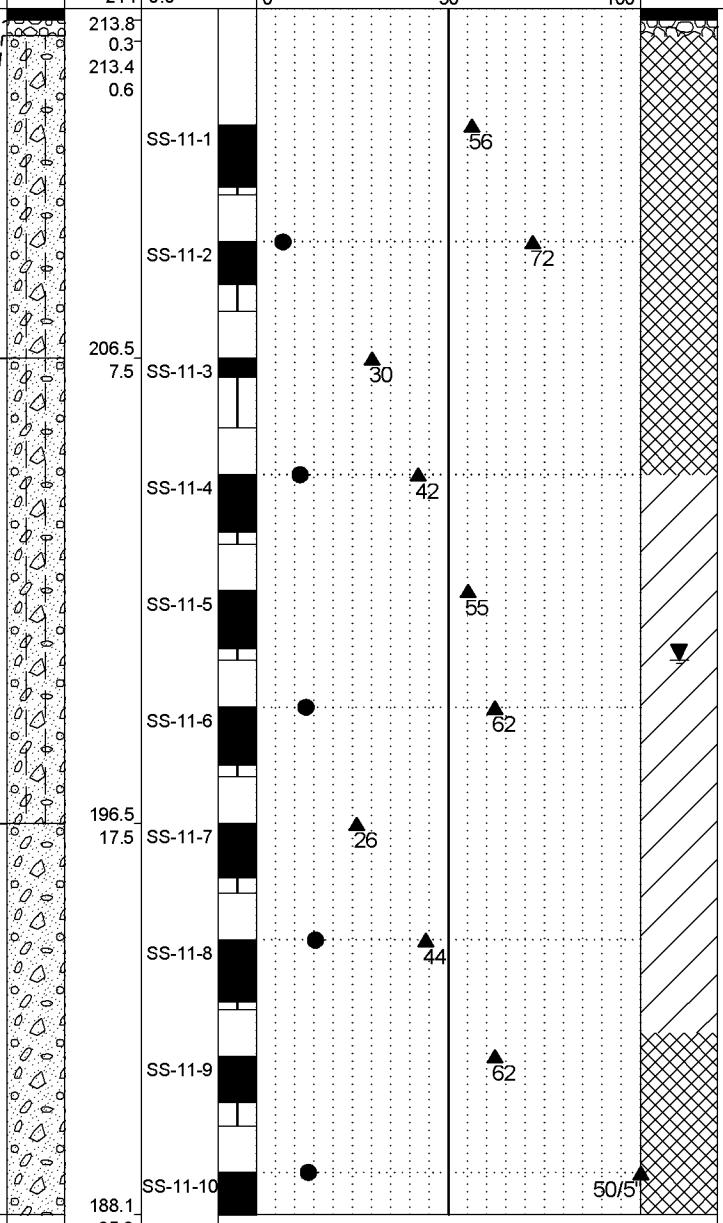
Depth Feet	Soil and Rock Description and Comments	Elev. Depth	Samples	Backfill/ Installations/ Water Table
		214	0.0	
1	ASPHALTIC CONCRETE (±3 inches).	213.8		Capped with AC cold patch and gravel
	Dense CRUSHED ROCK (GP); grey, dry, ±1 1/2-inch minus angular rock, (base rock).	0.3 / 213.4		
2	Very dense silty GRAVEL, some sand (GM); black and brown, dry to damp, low plasticity silt, medium to coarse sand, fine to coarse subangular to rounded gravel, (alluvium).	0.6		
3			SS-11-1	Backfilled with cuttings
4				
5			SS-11-2	
6				
7		206.5		
8	Dense sandy GRAVEL, some silt (GP-GM); black and brown, moist, low plasticity silt, medium to coarse sand, fine to coarse subangular to rounded gravel, (alluvium).	7.5	SS-11-3	
9				
10			SS-11-4	
11				
12				Bentonite chips
13	Very dense and iron-stained below ±12.5 feet.		SS-11-5	
14				Ground water encountered during drilling
15			SS-11-6	
16				
17				
18	Medium dense sandy GRAVEL, trace silt (GP); grey and brown, wet, low plasticity silt, fine to coarse sand, fine to coarse subangular to rounded gravel, (alluvium).	196.5 / 17.5	SS-11-7	
19				
20	Dense at ±20 feet.		SS-11-8	
21				
22				Cuttings
23	Very dense below ±22.5 feet.		SS-11-9	
24				
25			SS-11-10	
	BOTTOM OF BORING	188.1 / 25.9		



Project No.: 2181105

Surface Elevation: 214.0 feet (Approx.)

Date of Boring: October 18, 2018

Boring Log: BH-11

Cox Creek Sewer Interceptor

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Depth Feet	Soil and Rock Description and Comments	Elev. Depth	Samples	SPT, N-Value / Recovery / Moisture, % / RQD., %	Backfill/ Installations/ Water Table
		218	0.3	0 50 100	
1	ASPHALTIC CONCRETE (±4 inches).	217.7			Capped with AC cold patch and gravel
	Dense CRUSHED ROCK (GP); grey, dry, ±1 1/2-inch minus rock, (base rock).	0.3			
2	Very stiff SILT, scattered organics (ML); light brown and iron-stained, dry to damp, low plasticity, organics consist of fine roots, (alluvium).	217.0			
		1.0	SS-12-1	19	
3					
4					Backfilled with cuttings
5		213.0			
	Medium dense silty SAND (SM); brown, dry to damp, low plasticity silt, fine sand, (alluvium).	5.0	SS-12-2	17	
6					
7		210.5			
	Medium dense gravelly SAND, some silt (SP-SM); brown and grey, dry to damp, low plasticity silt, fine to medium sand, fine to coarse rounded gravel, (alluvium).	7.5	SS-12-3	19	
8					
9					
10		208.0			
	Medium dense sandy GRAVEL, trace silt (GP); brown and black, wet, low plasticity silt, fine to medium sand, fine to coarse subangular to rounded gravel, (alluvium).	10.0	SS-12-4	12	
11					
12					Ground water encountered during drilling
13			SS-12-5	30	
14					
15		203.0			
	Medium dense gravelly SAND (SP); brown and black, wet, fine to medium sand, fine rounded gravel, (alluvium).	15.0	SS-12-6	20	
16					Bentonite chips
17		200.5			
	Very dense sandy GRAVEL, trace silt (GP); brown and black, wet, low plasticity silt, medium to coarse sand, fine to coarse subangular to rounded gravel, (alluvium).	17.5	SS-12-7	56	
18					
19					
20			SS-12-8	71	
21					
22					Cuttings
23			SS-12-9	51	
24					
25	Some silt below ±25 feet.		SS-12-10	61	
26					
	BOTTOM OF BORING	191.5			
		26.5			

Project No.: 2181105

Surface Elevation: 218.0 feet (Approx.)

Date of Boring: October 18, 2018

Boring Log: BH-12

Cox Creek Sewer Interceptor

Albany, Oregon

Foundation Engineering, Inc.

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Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth	Samples	SPT, N-Value / Moisture, % / Recovery / RQD., % (0 – 50 – 100)	Backfill/ Installations/ Water Table
1	Medium stiff silty CLAY, some sand (CL); grey and brown and iron-stained, moist, low plasticity, fine sand, (alluvium).		218.5 0.0			Capped with sod (0 to ±0.5 feet)
2						
3				SS-13-1	8	Backfilled with cuttings
4			214.0 4.5			
5	Dense sandy GRAVEL, some silt (GP-GM); brown and black, moist, low plasticity silt, fine to coarse sand, fine to coarse subangular to rounded gravel, (alluvium).			SS-13-2	43	
6						
7						Bentonite chips
8				SS-13-3	38	
9						Ground water encountered during drilling
10	Medium dense and wet below ±10 feet.			SS-13-4	28	
11						
12			206.0 12.5			
13	Medium dense silty GRAVEL, some sand (GM); brown and black, wet, low plasticity silt, fine sand, fine to coarse subangular to rounded gravel, (alluvium).			SS-13-5	19	
14						
15			203.5 15.0			
16	Very dense sandy GRAVEL, some silt (GP-GM); brown and black, wet, low plasticity silt, fine to coarse sand, fine to coarse subangular to rounded gravel, (alluvium).			SS-13-6	57	
17						
18				SS-13-7	67	
19						
20				SS-13-8	54	
21						
22						
23				SS-13-9	76	
24						Cuttings
25	Medium dense at ±25 feet.			SS-13-10	28	
26						
	BOTTOM OF BORING		192.0 26.5			

Project No.: 2181105

Surface Elevation: 218.5 feet (Approx.)

Date of Boring: December 5, 2018

Boring Log: BH-13

Cox Creek Sewer Interceptor

Albany, Oregon

Foundation Engineering, Inc.

Last edited 1/23/19 mmw

Appendix C

Laboratory Testing

Foundation Engineering, Inc.
Professional Geotechnical Services

Table 1C. Moisture Contents, Percent Fines, & Atterberg Limits

Sample Number	Sample Depth (ft)	Moisture Content (percent)	% Fines	LL	PL	PI	USCS Classification
SS-1-2	5.0 – 6.5	13.1					
SS-1-4	10.0 – 11.5	8.1					
SS-1-6	15.0 – 16.5	11.9					
SS-1-8	20.0 – 21.5	80.0					
SS-1-10	25.0 – 26.5	47.9		79	53	26	MH
SS-1-12	30.0 – 31.5	62.8					
SS-2-2	5.0 – 6.5	19.5					
SS-2-4	10.0 – 11.5	9.0					
SS-2-5	12.5 – 14.0	6.3					
SS-2-8	20.0 – 21.5	12.6					
SS-2-10	25.0 – 26.5	15.3					
SS-2-11	27.5 – 29.0	30.7	17.4				
SS-2-12	30.0 – 31.5	23.9					
SS-3-2	5.0 – 6.5	13.4					
SS-3-4	10.0 – 11.5	7.5					
SS-3-6	15.0 – 16.5	10.0					
SS-3-8	20.0 – 21.5	16.2					
SS-3-10	25.0 – 26.5	16.7	15.8				
SS-3-12	30.0 – 31.5	20.7					
SS-4-2	5.0 – 6.5	12.3					
SS-4-4	10.0 – 11.5	8.9					
SS-4-6	15.0 – 16.5	19.2					
SS-4-8	20.0 – 21.5	13.7					
SS-4-9	22.5 – 24.0	32.7		59	38	21	MH
SS-4-10	25.0 – 26.5	40.4	60.9				
SS-5-2	5.0 – 6.5	5.2					
SS-5-4	10.0 – 11.5	6.9					
SS-5-6	15.0 – 16.5	11.4					
SS-5-8	20.0 – 21.5	11.1					
SS-5-9	22.5 – 24.0	25.1	49.9				
SS-5-10	25.0 – 26.5	28.7					

Table 1C. Moisture Contents, Percent Fines, & Atterberg Limits (Cont.)

Sample Number	Sample Depth (ft)	Moisture Content (percent)	% Fines	LL	PL	PI	USCS Classification
SS-7-2	5.0 – 6.5	11.8					
SS-7-4	10.0 – 11.5	13.5					
SS-7-6	15.0 – 16.5	11.3					
SS-7-8	20.0 – 21.5	16.1					
SS-7-10	25.0 – 26.5	12.6					
SS-8-2	5.0 – 6.5	12.2					
SS-8-4	10.0 – 11.5	17.6					
SS-8-6	15.0 – 16.5	13.1					
SS-8-8	20.0 – 21.5	21.3					
SS-8-10	25.0 – 26.5	45.9					
SS-9-2	5.0 – 6.5	10.9					
SS-9-4	10.0 – 11.5	11.9					
SS-9-6	15.0 – 16.5	10.9					
SS-9-8	20.0 – 21.5	30.2					
SS-10-2	5.0 – 6.5	11.7					
SS-10-4	10.0 – 11.5	9.0					
SS-10-6	15.0 – 16.5	9.4					
SS-10-8	20.0 – 21.5	32.7					
SS-10-10	25.0 – 26.5	27.2	20.9				
SS-10-12	30.0 – 31.5	14.7					
SS-11-2	5.0 – 6.5	6.9					
SS-11-4	10.0 – 11.5	11.3					
SS-11-6	15.0 – 16.5	12.8					
SS-11-8	20.0 – 21.5	15.3					
SS-11-10	25.0 – 26.5	13.5					
SS-12-2	5.0 – 6.5	14.7					
SS-12-4	10.0 – 11.5	11.1					
SS-12-6	15.0 – 16.5	17.9					
SS-12-8	20.0 – 21.5	11.5					
SS-12-10	25.0 – 26.5	13.0					

Table 1C. Moisture Contents, Percent Fines, & Atterberg Limits (Cont.)

Sample Number	Sample Depth (ft)	Moisture Content (percent)	% Fines	LL	PL	PI	USCS Classification
SS-13-2	5.0 – 6.5	10.2					
SS-13-4	10.0 – 11.5	11.6					
SS-13-6	15.0 – 16.5	14.1					
SS-13-8	20.0 – 21.5	12.1					
SS-13-10	25.0 – 26.5	15.9					