City of Springfield
Engineering and Transportation Division

Authorized by: Kenneth J Vogeney
Title: City Engineer
Date: 6/28/12

June 29, 2012

Addendum Number 1 to the Contract Documents for the Invitation to Bid for P21064; Jasper Trunk Sewer Phase 2

The City of Springfield is amending the above mentioned Invitation to Bid issued on May 29, 2012. This Addendum is hereby made a part of the original contract documents to the same extent as though it were originally included therein.

RENEWS 12-31-13

MURRAY, SMITH & ASSOCIATES, INC.
121 SW Salmon, Suite 900
Portland, OR 97204
(503) 225-9010

1.) In Supplementary Information, Appendix A, Reports by Others, REPLACE the incomplete Phase II Geotechnical Investigation, Jasper Trunk Sewer, Report (Geotech Report) with the attached, complete version of the Geotech Report labeled "City of Springfield P21064 Jasper Trunk Sewer – Phase 2 - Attachment A to Addendum 1 dated 06/29/2012".

2.) In Specification Section 02340, Casings and Appurtenances, on Page 4, in Paragraph 2.2B, after the second sentence, ADD the following sentence:

"Hydrostatic testing of the steel casing by the manufacturer will not be required."

3.) On Plan Sheet G-4, REPLACE General Note 39 with the following note:

"39. WHERE NEW TREES ARE INDICATED ON THE PLANS TO REPLACE EXISTING TREES TO BE REMOVED, REPLACEMENT TREES FOR EXISTING DECIDUOUS TREES SHALL BE OREGON OAK AND REPLACEMENT TREES FOR EXISTING CONIFEROUS TREES SHALL BE DOUGLAS FIR. REPLACEMENT TREES SHALL BE MINIMUM 2-INCH CALIPER."

4.) On Plan Sheets C-11, C-12, and C-13, ADD the following note:

"FOR ALL TREES TO BE REMOVED ON THIS SHEET, REMOVE ALL LIMBS, CUT TREES TO 40-FOOT TIMBER LENGTHS AND PLACE LOGS AT LOCATION APPROVED BY THE PROPERTY OWNER FOR THE PROPERTY OWNER'S USE. COORDINATE WITH THE PROPERTY OWNER FOR FINAL STOCKPILE LOCATION OF LOGS."

In the event that it is necessary to further amend, revise or supplement any part this Invitation to Bid additional addenda will be posted on the City's website at http://www.springfield-or.gov/Pubworks/P21064_Jasper_Trunk_Sewer_Phase_2.htm . The City will make a reasonable effort to provide the addenda to all Bidders to whom the City provided the initial Invitation to Bid. The City is not responsible for any explanation, clarification, interpretation or approval made or given in any manner except by written addenda issued by City.

All Addenda issued are considered to be part of the specifications of the Invitation to Bid and, as such, are incorporated into the Contract as specified in Section 104.02 of the Standard Construction Specifications.

By signing below, I acknowledge the receipt of the following Addendum documents and certify that the specifications contained have been considered and incorporated into the bid as presented.

ALL BIDDERS MUST ACKNOWLEDGE THIS ADDENDUM BY SIGNING AND DATING THIS DOCUMENT, LISTING IT ON THE BID ITEM LIST AND INCLUDING IT AS PART OF THEIR SUBMITTAL PACKAGE.

_____ _____

Signature Date

Phase II Geotechnical Investigation

Jasper Trunk Sewer

Springfield, Oregon

Prepared for:

Murray, Smith & Associates, Inc.
Portland, Oregon

July 14, 2010

Professional Geotechnical Services

Foundation Engineering, Inc.

Foundation Engineering, Inc.
Professional Geotechnical Services

William Evonuk, P.E.
Murray, Smith & Associates, Inc.
121 SW Salmon, Suite 900
Portland, Oregon 97204

July 14, 2010

Jasper Trunk Sewer
Phase II Geotechnical Investigation
Springfield, Oregon

Project 2091089-101

Dear Mr. Evonuk:

We have completed the requested Phase II geotechnical investigation for the above-referenced project. Our report includes a description of our work, a discussion of site and subsurface conditions, a summary of laboratory testing and a discussion of key geotechnical issues pertaining to the selected trunk sewer alignment. Boring logs and photographs of the rock cores are also provided.

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 if you require further assistance.

Sincerely,

FOUNDATION ENGINEERING, INC.

Erin Gillaspie
Engineering Staff

James K. Maitland, P.E., G.E.
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
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Brooke Running

Brooke Running, C.E.G.
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PHASE II GEOTECHNICAL INVESTIGATION
JASPER TRUNK SEWER
SPRINGFIELD, OREGON

BACKGROUND

The City of Springfield plans to construct a new trunk sewer along the Jasper Road corridor from South 42nd Street to ± ½ mile southeast of Bob Straub Parkway/Brand S Road. The project location is shown on Figure 1A (Appendix A).

The new sewer will be ± 18,000 feet long and may vary from 10 inches to possibly 27 inches in diameter. Key goals of the project include eliminating up to three existing pump stations and providing capacity for additional development in the southeast area of the City.

Murray, Smith & Associates, Inc. (MSA) is the prime designer. Foundation Engineering, Inc. (FEI) was retained by MSA as the geotechnical consultant. Our scope of work was summarized in a proposal dated October 26, 2009, and the work was approved by a Task Order under Agreement for Services dated October 29, 2009.

SCOPE OF WORK

The geotechnical work was completed in two phases. Phase I included a literature review of local subsurface information and a field reconnaissance of the alignment alternatives. Results of that work were summarized in a technical memorandum dated December 16, 2009, and were used in the alignment selection process. Phase II included exploratory drilling and sampling along the selected alignment, installation and monitoring of piezometers, laboratory testing and preparation of this report.

LITERATURE REVIEW

We performed a literature search to compile available information on the soil profiles and ground water levels near the site. Included in the review were geologic maps and water well logs. We conducted our search of local water well logs at the Oregon Department of Water Resources website. Please refer to the References section for specific literature sources.

FIELD RECONNAISSANCE

Our site reconnaissance within the public right-of-way was completed by Brooke Running, C.E.G. and James Maitland, P.E., G.E., in mid-November 2009. Our reconnaissance included traversing the three proposed alignments and observing and photographing the surface features to record variations in the local geology and topography. During our site visit, we also noted grade changes; evidence of shallow ground water; existing cut and fill slopes; potential road, railroad and utility conflicts; and other features that could impact the sewerline and wet well construction.

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LOCAL GEOLOGY

The Jasper Trunk Sewer project is located near the southern extent of the Southern Willamette Valley, between the Middle Fork of the Willamette River and the foothills of the Western Cascades. The alignment primarily runs along the north flood plain/bank of the Middle Fork of the Willamette River.

The proposed sewer alignment are typically capped with a mantle of various types of alluvium including clay, silt, sand and gravel; coarser alluvium of sand, gravel and cobbles; and braided, channelized fan deposits of silt to boulders (Hladky and McCaslin, 2006). These alluvial deposits are derived from sources associated with and directly from the Middle Fork of the Willamette River. Older, terrace gravels are also present within an isolated area and are typically weathered to clay and overlie volcaniclastic rocks of the Fisher Formation (Hladky and McCaslin, 2006). The Tuff of Dexter includes pyroclastic rocks primarily of tuff that, where unaltered, form resistant beds. Where the tuff is altered, it weathers to clay (Hladky and McCaslin, 2006). The Tuff of Dexter interfingers with conglomerate and sandstone of the Fisher Formation and both rock types are exposed within the rock cuts along the east extent of the alignment (Hladky and McCaslin, 2006). Outcrops of basalt and basaltic andesite are scattered along the western extent of the alignment.

There are no mapped potentially active faults that cross or are immediately adjacent to the recommended alignment (Personius et al., 2003; USGS, 2006). However, there are several locally-mapped, northeast-trending (older, inactive) faults along the southern half of the alignments. The southern extent of the faults terminate at or are obscured by alluvial deposits from the Middle Fork of the Willamette River (Hladky and McCaslin, 2006).

SELECTED ALIGNMENT

The trunk sewer project has an overall length of ±18,000 feet. It begins at the intersection of South 42nd Street and Jasper Road, and continues on Jasper Road ±2,900 feet south of the intersection with Bob Straub Parkway/Brand S Road. The 30% design report considered three alternative routes designated as Alternatives A, B and C. MSA has divided the recommended route into five reaches (Figure 2A, Appendix A). Individual reaches are shown on drawings provided by MSA and are presented, along with FEI borehole locations, on Figures 3A to 7A (Appendix A). Alternative C is the recommended route for Reaches 1 through 4 and Alternative A is recommended for Reach 5.

The recommended route generally follows the Jasper Road corridor for the full length of the project. Approximately 40% of the alignment would be located within the Jasper Road right-of-way. Beginning at the intersection of Jasper Road and South 42nd Street, the alignment extends east to a point where the Union Pacific Railroad (UPRR) tracks begin to parallel Jasper Road. At that point, the sewerline would cross the UPRR tracks and continue to the southeast, just east of the railroad right-of-way for a distance of ±12,000 feet. Within Reaches 3 and 4, two segments will loop to the east to avoid high quality wetland areas east of the railroad right-of-way. South

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of the Bob Straub Parkway/Jasper Road intersection, the route crosses the tracks and continues within the Jasper Road right-of-way, terminating at an existing railroad undercrossing.

DISCUSSION OF SITE CONDITIONS ALONG RECOMMENDED ALIGNMENT

The terrain within the Jasper Road corridor is relatively flat with gentle grade changes along most of the alignment. However, existing rock cuts are exposed within the west and east portions of the project area and subsurface conditions vary significantly along the proposed trunk sewer alignment.

Reach 1. Reach 1 (Figure 3A, Appendix A) is the most developed, straightest and flattest of the five reaches. A sidewalk along the north shoulder of Jasper Road terminates east of the roundabout at the intersection with South 42nd Street and the road shoulders are relatively narrow from the roundabout to Dixie Street/South 44th Street. The north shoulder has been extended ±100 feet west and ±450 feet east of Dixie Street/South 44th Street, to accommodate the Lucerne Meadows Pump Station and associated facilities. Approximately 50 feet west of South 47th Street/Ivy Street, a ±5-foot high knoll along the south shoulder has been cut to accommodate Jasper Road. The cut face is covered with ferns, blackberries and other low-lying brush and is composed of residual soil (clayey silt) with cobble to boulder-sized basaltic rock fragments. The cut slope is relatively stable with minor surface raveling and sloughing.

Reach 2. Within Reach 2 (Figure 4A, Appendix A), the western half of the recommended alignment follows Jasper Road along a curved, tree-lined grade rise to the north/east and includes several small cuts into residual soil and basaltic bedrock. Overall, the cut slopes appear to be stable, with established scrub Oak trees at the top and minor amounts of grass and ferns present on the slope. Minor sloughing and raveling was noted with some occasional cobble to boulder-sized, fresh to slightly weathered basalt fragments within the residual soil. A cut exposing more competent rock was observed between the residual soil road cuts. The rock is slightly weathered and fractured. Overhead power and phone/cable utilities run along the south/east shoulder of Jasper Road.

East of the small cuts and gentle rise in grade, the grade levels and abundant trees are present along the north shoulder and the UPRR tracks north of Jasper Road. A private drive extends south, providing access to the low-lying farmland. East of this driveway, the alignment opens up and contains fewer trees along the right-of-way and includes pastureland and orchards. The recommended alignment crosses the tracks and continues to parallel the north edge of the UPRR right-of-way.

The eastern portion of Reach 2 primarily crosses private farmland consisting of open pastureland and scattered trees and brush along fencelines. Standing water (perched) was also observed in some areas. The terrain consists of low-lying pastureland that likely contains soft soils. Perched ground water may impact trench construction during wet weather. Likely impacts include the need for dewatering and possible trench bottom stabilization for trenches extending into clay. The perched water is seasonal and could be mitigated by restricting trenching to dry weather.

Reach 3. The terrain within Reach 3 (Figure 5A, Appendix A) is relatively flat and the alignment primarily runs along Jasper Road and the UPRR right-of-way. Reach 3 begins at the Mt. Vernon Road intersection and typically follows the eastern edge of the UPRR right-of-way. The alignment along Reach 3 crosses rural, residential properties and a Springfield Utility Board (SUB) substation. The area surrounding the substation contains numerous overhead and underground utilities. Fiber optic line markers were also noted along the railroad right-of-way within this reach. Trees, brush, and areas of soft soils and occasional standing water were also observed. Impacts of perched water will be similar to those described above for Reach 2. There appears to be little, if any, access to the proposed alignment east of the railroad tracks.

Near the western end of Reach 3, the recommended alignment jogs to the north to avoid wetlands. This area is gently sloped and is grass covered with scattered blackberries. Access to this area would be from the private UPRR crossing for the lumber facility and access was not obtained for our explorations.

Reach 4. The terrain within Reach 4 is relatively flat. The current configuration of Bob Straub Parkway at the Jasper Road intersection is shown by dashed lines on Figure 6A (Appendix A).

The alignment continues to follow the eastern edge of the UPRR right-of-way. The alignment crosses rural residential properties, the entry for a lumber processing facility and the intersection of Bob Straub Parkway with Jasper Road. Trees, brush and areas of soft soil and occasional standing water were noted in this reach. At the Bob Straub Parkway intersection, the alignment jogs north to avoid a high quality wetland. This area is relatively flat, contains some private residences and is grass covered with scattered blackberries. Access to this area would be along a private drive and access was not obtained for our explorations.

Reach 5. The alignment crosses the UPRR tracks at the southern end of Reach 4 and continues along Jasper Road to the southern terminus (Figure 7A, Appendix A). This portion of Jasper Road is relatively flat with gentle curves and limited shoulder width to no shoulder. Cuts extend into the slope north/east of Jasper Road and the UPRR tracks. The road cuts are relatively shallow (±5 to 10 feet high) and expose conglomerate (Fisher Formation). The slopes appear stable, but some raveling of the rock surface was observed. Grass, small trees and blackberries cover the slope face. UPRR tracks run along a bench above the cut. Further uphill (east), is another vertical or near-vertical cut into bedrock (primarily tuff and conglomerate). Near the southern end of the reach, the grade becomes relatively flat again and the Middle Fork of the Willamette River approximately parallels Jasper Road to the west.

FIELD EXPLORATION

Between March 22 and 27, 2010, 13 boreholes were drilled along the recommended alignment. The boreholes were drilled with a CME-75, truck-mounted drill rig and mud-rotary drilling and HQ wire-line coring techniques. The boreholes were typically drilled ±10 feet below the anticipated invert elevation, except where intact rock was encountered, in which case, the drilling typically extended ±5 feet below the anticipated invert.

Samples were typically obtained at 2.5-foot intervals to the anticipated depth of the invert, and at 5-foot intervals thereafter. Disturbed samples were obtained with a split-spoon. The Standard Penetration Test (SPT), which is run when the split-spoon is driven, provides an indication of the relative stiffness or density of the soils. Relatively undisturbed samples of fine-grained soils were obtained at various depths using thin-walled Shelby tubes. Continuous rock core samples were obtained with a triple-barrel, HQ-size coring system.

One-inch diameter, PVC standpipe piezometers were installed at seven locations. The boreholes with piezometer installations are designated with a "p" (e.g., BH-2p) and the depths of the slotted sections are shown on the appended logs. Recorded ground water levels are discussed below.

The soil and rock profiles observed in the borings were continually logged during drilling. The final logs (Appendix B) were prepared based on a review of the field logs, an examination of the soil and rock samples in our office and results of laboratory testing. The approximate locations of the borings are shown in Figures 3A through 7A (Appendix A).

DISCUSSION OF SUBSURFACE CONDITIONS

Subsurface conditions at individual boring locations are discussed below. More detailed information is available in the boring logs (Appendix B). The locations of the borings were intended to provide an overview of subsurface conditions. However, the selection of drilling sites was often predicated on available access and utility or other conflicts. Therefore, extrapolation of subsurface information from widely spaced borings is inevitable.

The descriptions of soil or rock conditions at the invert level provided below were based on estimated pipe grades. Some variation in invert elevation may occur as the design progresses, or where the trunk sewer alignment diverges from the roadway.

BH-1

Boring BH-1 was advanced through the westbound travel lane of Jasper Road, ±275 feet east of the intersection with South 42nd Street. The ground surface at BH-1 lies at ±El. 490.04.

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A pavement section consisting of ±11 inches of asphaltic concrete (AC) followed by dense to very dense, sandy gravel (base rock) extends to ±2 feet. The pavement section is underlain by soft, low plasticity silt with scattered organics (alluvium) to ±7.5 feet. The silt contains some fine-grained sand from ±5 to 7.5 feet. The silt is followed by several strata of predominantly medium dense to very dense, sandy gravel (alluvium) to ±35.4 feet (the limits of exploration). Cobbles up to ±8 inches in diameter were noted between ±7.5 to 20.5 feet, based on drilling action. Some caving of the borehole occurred between ±9 to 16 feet and extensive caving occurred from ±28 to 30 feet. Drilling fluid loss was also noted between ±10 and 20 feet.

We estimate that the pipe invert at BH-1 will lie ±23 feet below the ground surface. Therefore, the pipe will be bedded in very dense, sandy gravel with trace to some cobbles (up to ±8 inches in diameter).

BH-2p

BH-2p was advanced through the north shoulder of Jasper Road, ±140 feet east of the intersection with South 44th Street. The ground surface at BH-2p lies at ±El. 491.06.

The subsurface profile at this location is similar to that encountered in BH-1. The pavement section consists of ±3 inches of AC followed by base rock consisting of very dense, sandy gravel and cobbles (up to ±4 inches in diameter) extending to ±2 feet. The pavement section is underlain by medium stiff, low plasticity silt (alluvium) to ±7 feet. The silt is followed by very dense, sandy gravel and cobbles (alluvium) to ±30.3 feet (the limits of exploration). The drilling action suggests the alluvium contains cobbles up to ±6 to 8 inches in diameter and that some caving occurred from ±25 to 27 feet.

We estimate that the pipe invert at BH-2p will lie ±18 feet below the ground surface. Therefore, the pipe will be bedded in very dense, sandy gravel and cobbles (up to ±6 to 8 inches in diameter).

BH-3

BH-3 was advanced through the westbound travel lane of Jasper Road, ±95 feet west of the intersection with South 47th Street. South of the boring, there is an outcrop of basaltic rock along Jasper Road. It can be assumed that the rock surface becomes shallower as the alignment approaches the hilly terrain and cut to the east. The ground surface at BH-3 lies at ±El. 499.68.

The pavement section consists of ±11 inches of AC followed by dense to very dense, sandy gravel with some silt (possible fill) to ±3.5 feet. The pavement section is underlain by hard, non-plastic silt (residual soil) to ±7.5 feet, followed by very dense, silty rock fragments (residual soil) to ±9 feet. Weak (R2), moderately to slightly weathered basalt was encountered at ±9 feet. The basalt becomes medium strong (R3) and slightly weathered below ±15 feet. Refer to Table 1C (Appendix C) for rock strengths.

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We estimate that the pipe invert at BH-3 will lie ±19 feet below the ground surface. Therefore, the pipe will be bedded in medium strong (R3), slightly weathered basalt.

BH-4

BH-4 was advanced through the westbound travel lane of Jasper Road, ±1,500 feet east of the intersection with South 47th Street. At this location, the terrain generally slopes from north to south. The rock surface is likely to be shallower as the alignment approaches the northern cut slope. The ground surface at BH-4 lies at ±El. 509.14.

The pavement section consists of ±11 inches of AC followed by dense to very dense crushed rock (base rock) to ±2 feet. The pavement section is underlain by medium dense to dense rock fragments with some low to medium plasticity silt (residual soil) to ±7 feet. Bedrock consisting of medium strong to strong (R3 to R4), moderately weathered basalt was encountered at ±7 feet and extends to at least ±21 feet (the maximum depth of the exploration). Refer to Table 1C for rock strengths.

We estimate that the pipe invert at BH-4 will lie ±16 feet below the ground surface. Therefore, the pipe will be bedded in medium strong to strong (R3 to R4), moderately weathered and highly fractured basalt.

BH-5p

BH-5p was advanced through the westbound travel lane of Jasper Road, near the proposed Union Pacific Railroad crossing ±2,000 feet west of the intersection with Mt. Vernon Road. The ground surface at BH-5p lies at ±El. 507.18.

The pavement section consists of ±6 inches of AC followed by ±8 inches of slurry seal/asphalt-treated base. The treated base is underlain by medium stiff, high plasticity, silty clay with trace to some sand and gravel (fill) to ±5 feet. The fill is followed by medium stiff, high plasticity clay (terrace gravel deposits) to ±10.5 feet. Dense to very dense, sandy gravel, cobbles and boulders (up to ±24 inches in diameter) with trace to some low plasticity silt (terrace gravel deposits) extend below the clay to ±19.5 feet. Medium stiff, non-plastic to low plasticity silt with trace to some fine-grained sand (terrace gravel deposits) was encountered from ±19.5 to 26.5 feet (the maximum depth of the exploration). The silt becomes very stiff below ±25 feet.

We estimate that the pipe invert at BH-5p will lie ±13 feet below the ground surface. Therefore, the pipe will be bedded in dense to very dense, sandy gravel, cobbles and boulders (up to ±24 inches in diameter).

BH-6p

BH-6p was advanced through the gravel pull-out shoulder northwest of the intersection of Jasper Road and Mt. Vernon Road. The ground surface at BH-6p lies at ±El. 520.00.

Dense to very dense, sandy gravel and cobbles up to ±10 inches in diameter (fill) extends below the ground surface to ±2 feet. The fill is underlain by medium stiff, low plasticity, sandy silt with trace gravel and organics (possible fill/alluvium) to ±5 feet. High plasticity, clayey silt (terrace gravel deposits) extends below the possible fill/alluvium to ±36.5 feet (the maximum depth of the exploration). The clayey silt is soft from ±5 to 12 feet, medium stiff to stiff from ±12 to 30 feet, very stiff from ±30 to 35 feet, and stiff below ±35 feet.

We estimate that the pipe invert at BH-6p will lie ±26 feet below the ground surface. Therefore, the pipe will be bedded in stiff, high plasticity, clayey silt.

BH-7

BH-7 was advanced through the westbound travel lane of Jasper Road, ±2,000 feet east of the intersection with Mt. Vernon Road. The ground surface at BH-7 lies at ±El. 515.15.

The pavement section at BH-7 consists of ±6 inches of AC followed by ±12 inches of slurry seal/asphalt-treated base. The treated base is underlain by medium stiff, high plasticity clay with trace to some sand (terrace gravel deposits) to ±5 feet. The clay is underlain by medium dense to dense, silty gravel and cobbles (up to ±8 inches in diameter) with some clay and sand (terrace gravel deposits) to ±8 feet. Very dense, sandy gravel (terrace gravel deposits) extends below the silty gravel to ±12 feet. Very stiff, low to medium plasticity silt (possible terrace gravel deposits) was encountered from ±12 to 15 feet, and is underlain by extremely weak (R0), highly to moderately weathered mudstone to ±25.4 feet (the maximum depth of the exploration).

We estimate that the pipe invert at BH-7 will lie ±14 feet below the ground surface. Therefore, the pipe will be bedded in very stiff, low to medium plasticity silt. Because the bedrock surface in BH-7 is so close to the estimated invert, it is possible that some of the pipe in this area will extend to mudstone.

BH-8p

BH-8p was advanced through the westbound travel lane of Jasper Road, ±2,300 feet west of the intersection with Bob Straub Parkway. The ground surface at BH-8p lies at ±El. 524.42.

The pavement section at BH-8 consists of ±12 inches of AC followed by ±4 inches of slurry seal/asphalt-treated base. The treated base is underlain by possible alluvium consisting of medium stiff to stiff, medium plasticity silt with some sand, gravel and cobbles (up to ±12 inches in diameter) to ±11.5 feet. Stiff, medium plasticity, clayey silt with some gravel-sized rock fragments (residual soil) extends below the possible alluvium to ±22 feet. Stiff, medium to high plasticity, silty clay (residual soil) was encountered from ±22 to 36.5 feet (the maximum depth of the exploration).

We estimate that the pipe invert at BH-8p will lie ±23 feet below the ground surface. Therefore, the pipe will be bedded in stiff, silty clay with some rock fragments.

BH-9

BH-9 was advanced through the eastbound travel lane of Jasper Road, ±1,300 feet west of the intersection with Bob Straub Parkway. The ground surface at BH-9 lies at ±El. 524.38.

The pavement section at BH-9 consists of ±12 inches of AC, underlain by medium dense, clayey sand with some gravel (possible fill) to ±3 feet. The clayey sand is underlain by dense, clayey gravel and cobbles (up to ±12 inches in diameter) with some sand and very dense, sandy gravel and cobbles with some clay to ±12 feet. Very stiff, low to medium plasticity silt with trace to some gravel-sized rock fragments (residual soil) extends below the gravel and cobbles to the bedrock surface at ±17.5 feet. Extremely weak (R0), moderately weathered lithic mudstone extends below the residual soil to at least ±30.9 feet (the maximum depth of the exploration).

We estimate that the pipe invert at BH-9 will lie ±19 feet below the ground surface. Therefore, the pipe will be bedded in extremely weak (R0), moderately weathered lithic mudstone.

BH-10p

BH-10p was advanced through the north shoulder of Jasper Road, ±550 feet west of the intersection with Bob Straub Parkway. The ground surface at BH-10p lies at ±El. 527.01.

Dense gravel (fill) extends below the ground surface to ±18 inches and is underlain by medium stiff to stiff, high plasticity, silty clay (alluvium) to ±7.5 feet. The silty clay contains trace to some fine to medium-grained sand below ±5 feet. Very dense, clayey gravel and cobbles (alluvium) extends below the silty clay to ±14.5 feet. Hard, low to medium plasticity silt (residual soil) underlies the alluvium to the bedrock surface at ±26 feet. Very weak (R1), moderately to slightly weathered sandstone (Fisher Formation) was encountered from ±26 to 27.8 feet (the maximum depth of the exploration).

We estimate that the pipe invert at BH-10p will lie ±17 feet below the ground surface. Therefore, the pipe will be bedded in residual soil consisting of hard silt with some sand-sized rock fragments.

BH-11p

BH-11p was advanced through the north shoulder of Jasper Road, near the proposed Union Pacific Railroad and Jasper Road crossing, ±1,600 feet east of the intersection with Bob Straub Parkway. The ground surface at BH-11p lies at ±El. 531.30.

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Medium dense to dense, sandy gravel with some silt (fill) extends to ±3.5 feet. The drilling suggests the presence of a possible boulder (±18 inches in diameter) in the fill. The fill is underlain by braided-fan alluvial deposits consisting of loose, silty sand with scattered organics, clay lens from ±5 to 6 feet and gravel and cobbles below ±6.5 feet. Hard, sandy silt (residual soil) extends below the braided-fan deposits to the bedrock surface at ±12 feet. Extremely weak to very weak (R0 to R1), slightly weathered sandstone (Fisher Formation) extends below the residual soil to ±27.8 feet (the maximum depth of the exploration).

We estimate that the pipe invert at BH-11p will lie ±17 feet below the ground surface. Therefore, the pipe will be bedded in extremely weak to very weak (R0 to R1), slightly weathered sandstone.

BH-12

BH-12 was advanced through the westbound travel lane of Jasper Road, ±2,500 feet east of the intersection with Bob Straub Parkway. Although a large, steep outcropping of rock rises to the north/east, bedrock was not encountered at BH-12 to the limits of exploration. The ground surface at BH-12 lies at ±El. 526.52.

The pavement section at BH-12 consists of ±12 inches of AC followed by ±2 inches of slurry seal/asphalt-treated base. The treated base is underlain by medium dense, silty gravel with some sand (alluvium) to ±10 feet. The silty gravel is followed by soft, sandy silt (alluvium) to ±15.5 feet. Hard, sandy silt with some clay (alluvium) extends from ±15.5 to 21.5 feet and is followed by dense, sandy gravel with some silt, cobbles and organics to ±24 feet (the maximum depth of the exploration).

We estimate that the pipe invert at BH-12 will lie ±11.5 feet below the ground surface. Therefore, the pipe will be bedded in soft, sandy silt.

BH-13p

BH-13p was advanced through the westbound travel lane of Jasper Road, near the eastern terminus of the project ±3,200 feet east of the intersection with Bob Straub Parkway. The ground surface at BH-13p lies at ±El. 526.41.

The pavement section at BH-13p consists of ±12 inches of AC followed by ±3 inches of slurry seal/asphalt-treated base. The treated base is underlain by medium stiff, high grading to medium plasticity, clayey silt (alluvium) to ±10 feet, followed by stiff, sandy silt with trace to some gravel (alluvium) to the bedrock surface at ±12.5 feet. The drilling action suggests that scattered cobbles are present in the sandy silt. Extremely weak (R0), highly to moderately weathered lithic sandstone (Fisher Formation) extends below the alluvium to ±18.3 feet (the maximum depth of the exploration).

We estimate that the pipe invert at BH-13p will lie ±6.5 feet below the ground surface. Therefore, the pipe will be bedded in medium stiff, high to medium plasticity, clayey silt.

Ground Water

Areas of ponded water were noted along many portions of the trunk sewer alignment during the 2009/2010 winter. This water represents a perched condition that typically develops in flat or low-lying areas and should be expected during wet weather.

Seven piezometers were installed in selected borings. The ground water levels recorded to date and estimated depths to invert are summarized in Table 1.

The data collected to date indicates that ground water levels along the alignment fluctuate an average of ±3 to 4 feet seasonally and possibly more, but typically lie above the planned invert. Therefore, the need for dewatering while trenching should be anticipated. Contractors should measure the water levels in the piezometers prior to preparing bids and prior to construction to obtain the latest water levels, evaluate potential ground water impacts and plan their dewatering methods.

Table 1. Ground Water Measurements

	BH-2p	BH-5p	BH-6p	BH-8p	BH-10p	BH-11p	BH-13p
Estimated Pipe Invert Depth (feet)	18.0	13.0	26.0	23.0	17.0	17.0	6.5
Elevation	473	494	494	501	510	514	520
Water Level April 6, 2010 Depth (feet)[1]	11.90	5.75	3.85	3.15	10.30	4.60	7.80
Elevation[2]	479.2	501.4	516.2	521.3	516.7	526.7	518.6
Water Level July 7, 2010 Depth (feet)[1]	12.50	14.30	8.70	9.15	11.90	5.65	8.10
Elevation[2]	478.6	492.9	511.3	515.3	515.1	525.7	518.3

Notes: 1. Measured from the top of the monument (which is typically flush with the ground surface).
2. Water surface elevations were estimated from survey data provided by MSA.

LABORATORY AND FIELD TESTING

The laboratory work included natural water contents and Atterberg limits tests to classify the foundation soils according to the Unified Soil Classification System (USCS), determine their homogeneity and estimate their overall engineering properties. Unconfined compression tests were run on selected samples of the rock core to estimate the shear strength of the rock.

Results of the natural water contents, Atterberg limits and unconfined compression tests are summarized in Table 1C and Figure 1C (Appendix C).

We completed in-situ resistivity testing at selected locations on March 22 and 27, 2010, using a Nilsson 400, 4-pin, soil resistance meter (ASTM G 57). The tests were typically completed near each boring, although suitable locations were not available near BH-4, BH-9 and BH-12. The 4-pin resistance meter provides an estimate of the average resistivity of a soil profile extending to a depth equal to the spacing between the pins. The tests were performed with the pins spaced to bracket the estimated invert depth. The resistivity values are summarized in Table 2C (Appendix C).

Laboratory pH testing (ASTM G 51) was completed on samples obtained in BH-5p through BH-10p, as well as BH-12 and BH-13p, at depths close to the estimated pipe invert. The soils near the invert at BH-1 through BH-4 and BH-11p were too gravelly for pH meter use. The results on samples tested indicate a soil pH range of 5.0 to 6.7. The pH test results are summarized in Table 3C (Appendix C).

DISCUSSION OF KEY GEOTECHNICAL ISSUES

The anticipated soil, rock and ground water conditions within the five reaches are summarized below. The subsurface conditions are known only at the boring locations, and the elevation of the sewer invert varies along the recommended alignment. Therefore, the discussion below represents an extrapolation of widely-spaced data and variability of these conditions should be anticipated along the sewer alignment.

Anticipated Subsurface Conditions (Soil, Rock and Ground Water)

Reach 1. We assume that the subsurface profiles encountered in BH-1 and BH-2p are representative of ±1,200 feet of the alignment. The extent to which these borings represent conditions east of BH-2p is currently unknown.

Conditions at those two borings indicate the trenching for the trunk sewer should encounter the pavement section followed by medium stiff silt. Excavation to ±7 feet is not expected to be difficult. The silt is underlain by dense to very dense gravels and cobbles to the anticipated invert of the pipe in this portion of the reach (a depth of ±18 to 23 feet). Excavation in the gravel and cobbles is expected to be significantly more difficult than the overlying silt. In addition, the loss of drilling fluid suggests some of the gravel and cobbles may be poorly-graded and highly permeable.

Caving of the gravel and cobbles was noted above and below the invert elevation. Caving of trench sidewalls should be expected in the gravel and cobbles above the invert, particularly if ground water is present. Ground water was encountered in BH-2p at ±12 feet on April 6, 2010, and the recharge rate following bailing was rapid.

We anticipate that the ground water level will lie above the pipe invert at most locations along Reach 1. Therefore, shoring will be necessary to protect workers from caving soils, especially in the gravels encountered along the western portion of Reach 1. Caving soils are not expected to be as significant a concern near BH-3, where relatively shallow bedrock is present. However, dewatering of the excavation will be required.

BH-3 probably characterizes at least the eastern-most ±600 to 700 feet of the eastern portion of Reach 1. However, contractors should expect the surface of the bedrock to become more shallow east of BH-3 as one approaches the hillside.

Trenching in the vicinity of BH-3 should encounter the pavement section followed by hard silt to ±7 feet followed by ±2 feet of rock fragments in a soil-like matrix. Therefore, digging with conventional equipment (i.e., a large excavator) is expected to be practical to ±9 feet. Weak (R2) grading to medium strong (R3) basalt is present to the invert depth (±19 feet). Contractors should plan on pre-splitting or fracturing with a hydraulic ram once the rock is encountered.

Reach 2. A hillside lies to the north and west of the initial portion of Reach 2 and rock is exposed in the road cut along this portion of the alignment. Conditions in BH-3 and BH-4 likely characterize the western ±1,200 feet of the trunk sewer alignment. The rock surface appears to dip to the south and east and the depth at which rock may be encountered east of BH-4 is not known. For planning purposes, we recommend assuming rock (basalt) may be encountered in trenches within at least ±300 feet east of BH-4.

Trenching in the initial ±1,200 feet of Reach 2 is expected to encounter hard silt or residual soil (rock fragments in a soil matrix) to ±7 feet. The quality of the rock may vary from weak to medium strong (R2 to R3) at BH-3 to medium strong to strong (R3 to R4) at BH-4. It is possible that a large excavator could trench through the highly fractured rock similar to that found in BH-4, however, contractors should plan on hard rock removal for this section of the reach. Based on an estimated invert depth of ±16 to 19 feet, we anticipate that the bottom of the trench will extend into rock.

BH-5p and BH-6p characterize the eastern ±1,800 feet of Reach 2. Trenching is expected to encounter predominantly ±5 feet of fill, medium stiff, high plasticity clay and gravel to boulders with depth. The bottom of the trench at BH-5p is expected to extend into dense to very dense gravel with cobbles and boulders (based on an estimate invert depth of ±13 feet). At BH-6p, the bottom of the trench is expected to extend into high plasticity, clayey silt (based on an estimated invert of ±26 feet). If ground water is present, softening of the clayey silt and trench bottom stabilization should be expected.

Ground water was encountered in BH-5p at ±5.75 feet and the rate of recharge was very rapid. An initial water level of ±3.85 feet was recorded in BH-6p. However, most of the subsurface profile at BH-6p consists of high plasticity, clayey silt. This soil has low permeability characteristics. Therefore, much of this water may have been induced while drilling. On April 6, after bailing, the water level in BH-6p rose ±1 foot over ±2 hours, indicating a slow recharge rate.

We anticipate that the ground water level will lie well above the pipe invert at most locations along Reach 2. Therefore, the need for shoring and dewatering of the excavation should be anticipated.

Reach 3. The subsurface profiles at BH-6p, BH-7 and BH-8p characterize Reach 3. Variable conditions should be expected within this reach based on the varying conditions encountered in the three borings. Trenching is expected to encounter predominantly silts, clays, dense gravels with cobbles, and residual soil (stiff, clayey silt). Extremely weak (R0) mudstone (Fisher Formation) was encountered at ±15 feet in BH-7. Because of the proximity of the bedrock to the invert (±14 feet) at this location, the trenching may encounter mudstone in portions of the reach. Trench bottom conditions are expected to vary from plastic clay (near BH-6p), residual soil or mudstone (BH-7), or residual soil (uphill from BH-8p).

Based on the recorded SPT N values, we anticipate excavation can be completed using conventional equipment. Access was not available for drilling the loop extending uphill from BH-8p. We anticipate that bedrock will become shallower uphill (north) of the Jasper Road. Therefore, this loop may encounter residual soil and mudstone at shallower depths than those indicated at BH-8p.

An initial water level of ±3.15 feet was recorded in BH-8p. However, most of the subsurface profile at BH-8p consists of medium to high plasticity silt to silty clay with a low permeability. Therefore, much of this water may have been induced during drilling and had not had sufficient time to dissipate prior to reading the water level. After bailing, the water level in BH-8p rose ±7 feet over ±30 minutes, indicating a slow to moderate rate of recharge.

The ground water level appears to lie well above the pipe invert at most locations along Reach 3. Therefore, the need for shoring and dewatering of the excavation should be anticipated.

Reach 4. Subsurface conditions within Reach 4 are characterized by borings BH-8p through BH-11p. To avoid a wetland, no drilling was completed along the loop that extends north of Jasper Road near Brand S Road. Therefore, conditions for the loop will have to be extrapolated from nearby borings BH-10p and BH-11p.

Trenching is expected to encounter a stratified profile that includes stiff to very stiff silt; medium dense sand; dense, sandy gravels and cobbles, and bedrock (mudstone). Trench conditions at the north end of the reach are described above (BH-8p). Near BH-9, trenching is expected to extend into extremely weak lithic mudstone (based on an estimated invert depth of ±19 feet). In the vicinity of

BH-10p, the trench bottom is expected to extend into hard silt with some rock fragments (based on an estimated invert depth of ±17 feet). At this location, the bedrock (very weak sandstone) appears to lie well below the pipe invert. At BH-11p, the surface of the extremely weak (R0) to very weak (R1) sandstone was encountered at ±12 feet, ±5 feet above the estimated invert depth of ±17 feet. Practical sampling refusal (N>100) was recorded in the sandstone. It has been our experience that large excavators can dig into the sandstone, depending on the actual trench width and the amount of fracturing present in the rock. However, excavation in sandstone should be expected to be slow or very slow. Contractors should anticipate that the surface of the sandstone will be shallower within the loop uphill of BH-10p and BH-11p.

Ground water was encountered in BH-10p at ±10.3 feet and recharged very rapidly. Ground water in BH-11p was initially encountered at ±4.6 feet and did not significantly fluctuate for ±1 hour after being bailed, indicating a slow recharge rate.

The ground water level lies above the pipe invert at most locations along Reach 4. Therefore, the need for shoring and dewatering of the excavation should be anticipated, particularly where gravels are present above the ground water table.

Reach 5. The depth of the sewer invert is expected to range from ±17 feet (at BH-11p) to ±6.5 feet (at BH-13p, the terminus of the project). Conditions at BH-11p are described above. Trenching is expected to encounter predominantly gravels (near BH-12) and plastic clay (near BH-13p).

At BH-12, the trenching is expected to extend into soft, sandy silt with organics at the invert depth of ±11.5 feet. Contractors should anticipate that overexcavation of the trench bottom and rock stabilization will be required in this section of the reach. Although the clay is stiffer at BH-13p, some trench bottom stabilization may be required, if the soil softens in the presence of ground water.

Ground water was encountered at ±7.8 feet in BH-13p on April 6. After bailing, the water level rapidly recharged.

The ground water level appears to lie above the pipe invert along the western portion of Reach 5, and below the invert elevation in the east. Therefore, the need for shoring and dewatering of the excavation should diminish as construction progresses eastward.

Trench Wall Stability

Trunk sewer trenching is expected to encounter a large range of subsurface conditions including fine-grained soils (silts and clays), alluvial sands and gravel, residual soils and bedrock (basalt, mudstone and sandstone). Potential caving of trench sidewalls should be expected throughout the alignment, in particular in sands and gravels. The risk is significantly higher if seepage develops in the granular soils. Contractors should plan to provide shoring to protect workers from sloughing or caving sidewalls along the entire alignment.

City of Springfield P21064 Jasper Trunk Sewer – Phase 2 - Attachment A to Addendum 1 dated 06/29/2012 - Page 17

Liquefaction Hazard

The field exploration suggests the trunk sewer will extend through and bed in a variety of materials. Those materials include relatively stiff, plastic silt and clay, dense gravels and cobbles and bedrock. Because of their density or stiffness, none of these materials are susceptible to liquefaction. Therefore, the risk of liquefaction during a seismic event is believed to very low.

RECOMMENDATIONS

Contractors bidding on the trunk sewer project should be provided a copy of this report and should be familiar with the boring logs, the definitions of rock hardness/strength found on the "Common Terms of Rock Descriptions Key" in Appendix B, results of rock strength testing in Table 1C (Appendix C), the discussion of subsurface conditions, and the limitations of this information. Photographs of the recovered rock core are appended (Photo 1 through Photo 4, Appendix B). Soil and rock core specimens are available for inspection by contractors prior to bidding. Contractors should also make their own site inspection to familiarize themselves with existing utilities, railroads, roads, conflicts, access, rock exposures, etc.

Ground water levels will vary seasonally. Perched ground water conditions and infiltration of surficial water should be expected for any trenching conducted during the winter through early summer. Piezometer data indicates that the ground water levels may rise to ±17 feet above the planned invert elevation in summer and ±22 feet above the planned invert elevation in spring. Ground water levels should be measured in the seven available piezometers prior to bids and prior to construction, so that the contractor can plan his dewatering effort accordingly.

OSHA Soil Type B and C soils were typically encountered in the borings. However, soil and rock conditions should be expected to vary along the alignment and ground water levels will fluctuate seasonally and by location. Therefore, we recommend the contractor assume an OSHA Soil Type C for planning and design of trenching. A maximum open slope excavation of 1½:1 (H:V) is recommended.

Lateral pressure diagrams for the design of the temporary shoring through predominantly granular and fine-grained soils are shown in Figures 8A and 9A (Appendix A), respectively. These pressure diagrams assume an average of the soil profiles encountered in the borings. For example, the subsurface profile at BH-1 through BH-4 typically consists of sandy/silty gravel to the invert depth or to bedrock. Therefore, the shoring from ±Sta. 0+00 to 50+00 should be based on the lateral earth pressure diagram for granular soils (Figure 8A). BH-5p and BH-6p encountered predominantly clay to the invert depths. Therefore, Figure 9A would be appropriate from ±Sta. 50+00 to 80+00. Contractors should adjust their shoring design based on the actual conditions encountered in the field. Caution should be used in classifying a soil profile "predominantly fine-grained". It would be prudent to use the diagram in Figure 8A if a fine-grained soil profile contains a significant granular component (e.g., near BH-8p).

A conservative unit weight of 125 pcf and internal friction angle (Φ value) of 32 degrees were assumed for the granular soils. A unit weight of 100 pcf and undrained shear strength (S_u) of 500 psf were assumed for the fine-grained soil. Apparent earth pressure distributions recommended by Peck for sand and medium clay were assumed to represent the predominant soil conditions. Lateral pressures in bedrock can be assumed to be negligible.

It is possible the contractor's equipment will surcharge the edge of the excavation. Since the surcharge load is unknown at this time, the lateral earth pressure resulting from equipment is shown as a uniform surcharge pressure, q_s, multiplied by an assumed at-rest coefficient of ± 0.4.

Sections of the alignment that expose silt or clay may soften in the presence of ground water. Therefore, bid documents should include a unit cost for ± 2 feet of trench bottom stabilization with 3-inch minus, angular, open-graded, crushed rock over a woven geotextile meeting the requirements of an AASHTO M 288-05 Class 2 geotextile.

DESIGN REVIEW/CONSTRUCTION OBSERVATION/TESTING

We should be provided the opportunity to review all drawings and specifications that pertain to design and construction of the proposed trunk sewer. Site preparation will require field confirmation of the depth to rock and ground water. Mitigation of any ground water infiltration, caving sidewalls or soft trench bottom conditions will also require engineering review and judgment. That judgment should be provided by one of our representatives. Frequent field density tests should be run on all engineered fill, subgrade and base rock. We recommend that we be retained to provide the necessary construction observation and testing.

VARIATION OF SUBSURFACE CONDITIONS, USE OF THIS REPORT AND WARRANTY

The analysis, conclusions and recommendations contained herein are based on the assumption that the soil and rock profiles and the ground water levels encountered in the borings are representative of overall site conditions. The above recommendations assume that we will have the opportunity to review final drawings and be present during construction to confirm assumed foundation conditions. No changes in the enclosed recommendations should be made without our approval. We will assume no responsibility or liability for any engineering judgment, inspection or testing performed by others.

This report was prepared for the exclusive use of Murray, Smith & Associates and other design consultants for the Jasper Trunk Sewer project in Springfield, Oregon. Information contained herein should not be used for other sites or for unanticipated construction without our written consent. This report is intended for planning and design purposes. It should be clearly understood that subsurface conditions are well known only at the boring locations and that conditions assumed for other portions of the recommended trunk sewer alignment required extrapolation from widely-spaced borings. Contractors using this information to estimate construction

quantities or costs do so at their own risk. Contractors are encouraged to measure ground water levels in the available piezometers prior to preparing bids and beginning construction. FEI should be contacted to coordinate those measurements.

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 that those services, if needed, have been completed by others.

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

REFERENCES

Hladky, F. R., and McCaslin, G. R., 2006; Preliminary Geologic Map of the Springfield 7.5' Quadrangle, Lane County, Oregon, Oregon Department of Mineral Industries, Open-File Report O-06-07, p. 31.

Personius, S. F., Dart, R. L., Bradley, L.-A., and Haller, K. M., 2003; Map of Quaternary Faults and Folds in Oregon, U.S. Geological Survey, Open-File Report 03-095, v.1.1, Scale: 1:750,000.

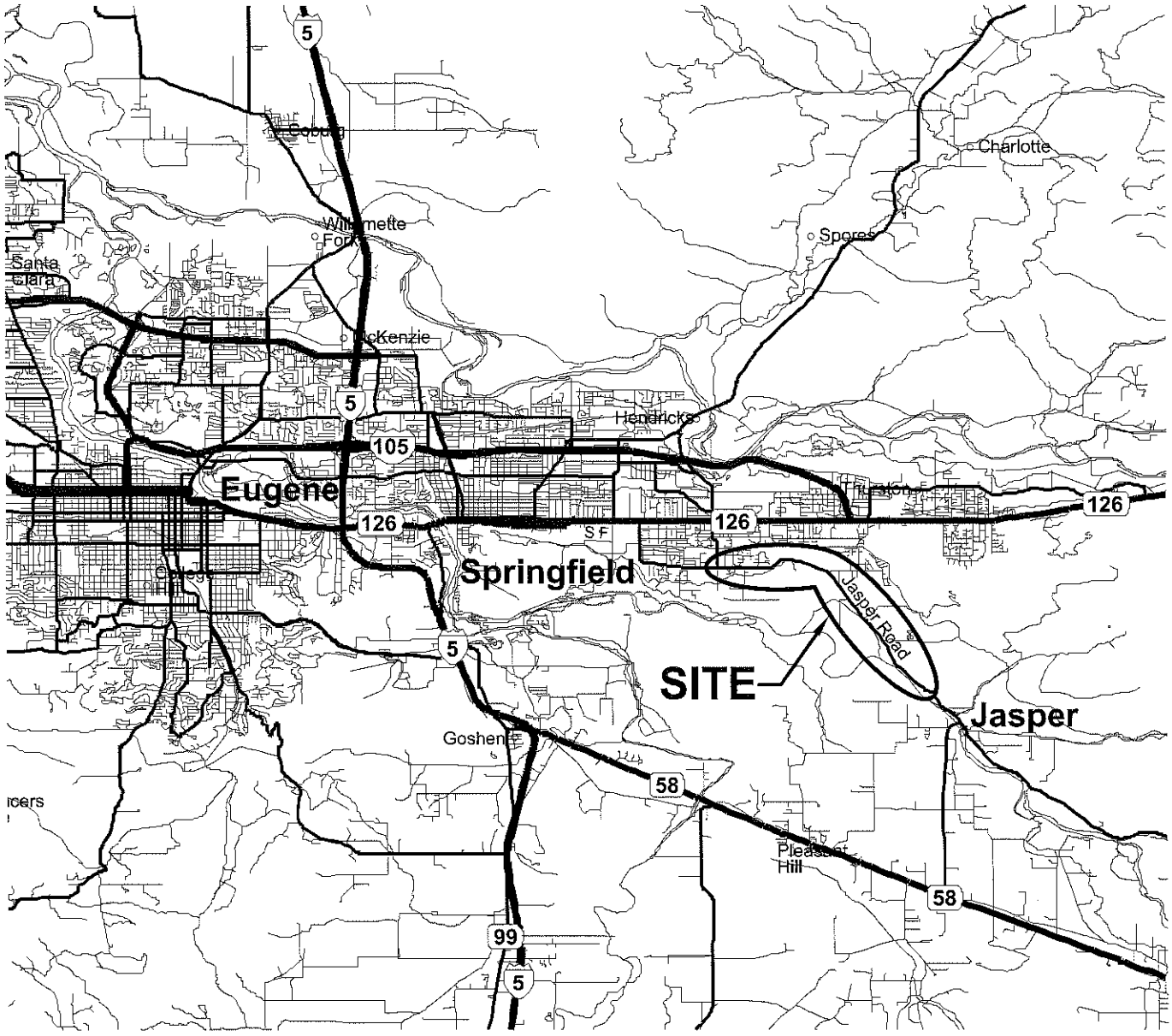
USGS, 2006; Quaternary Fault and Fold Database for the United States: accessed November 2009, from USGS web site, http://earthquake.usgs.gov/regional/qfaults/or/index.php.

Appendix A

Figures

Professional
Geotechnical
Services

Foundation Engineering, Inc.



DATE MAR 2010
DWN. EG
APPR.
REVIS.
PROJECT NO.
2091089-101

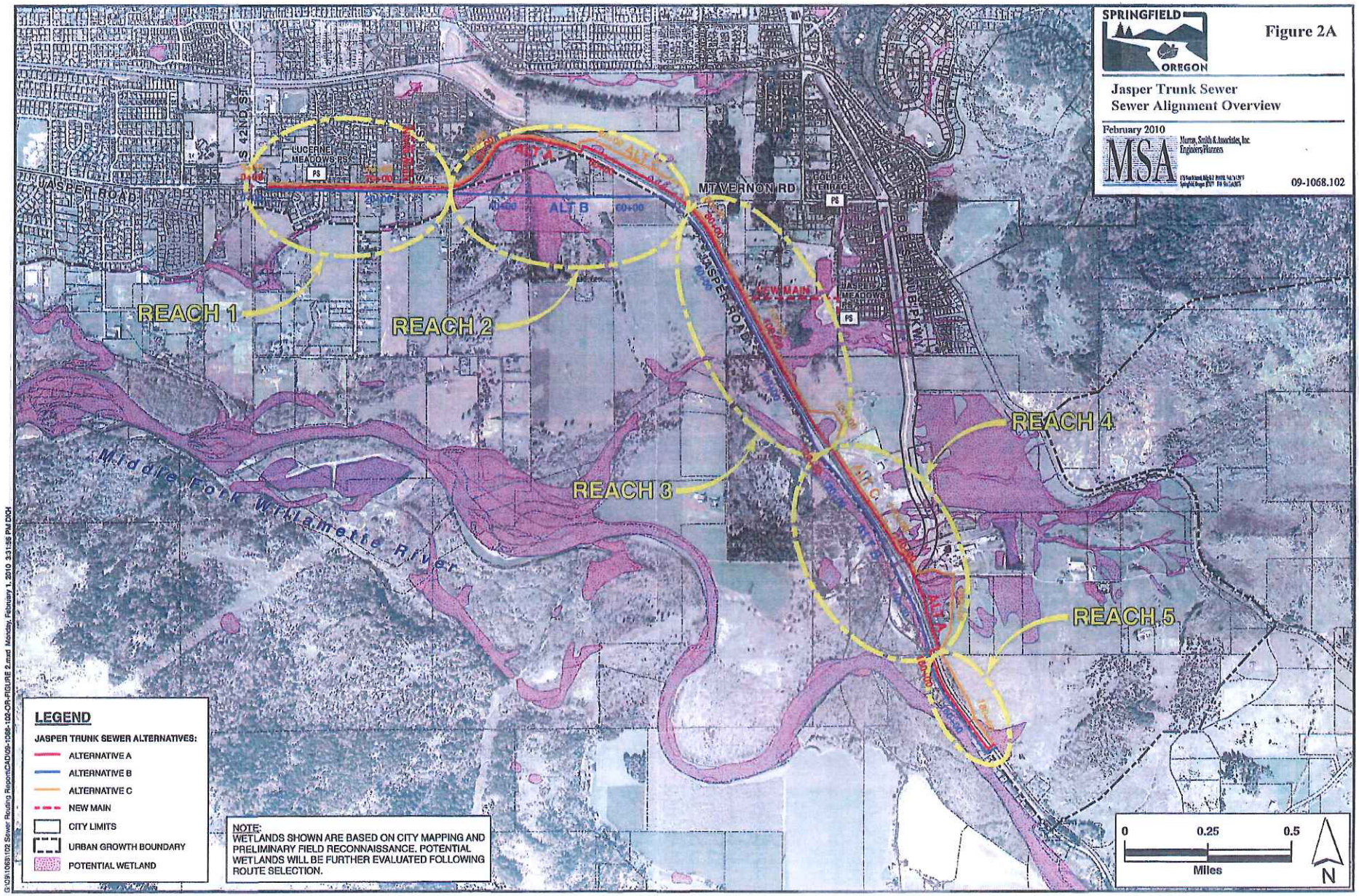
FOUNDATION ENGINEERING INC.
PROFESSIONAL GEOTECHNICAL SERVICES
820 NW CORNELL AVENUE
CORVALLIS, OR 97330-4517
BUS. (541) 757-7645 FAX (541) 757-7650

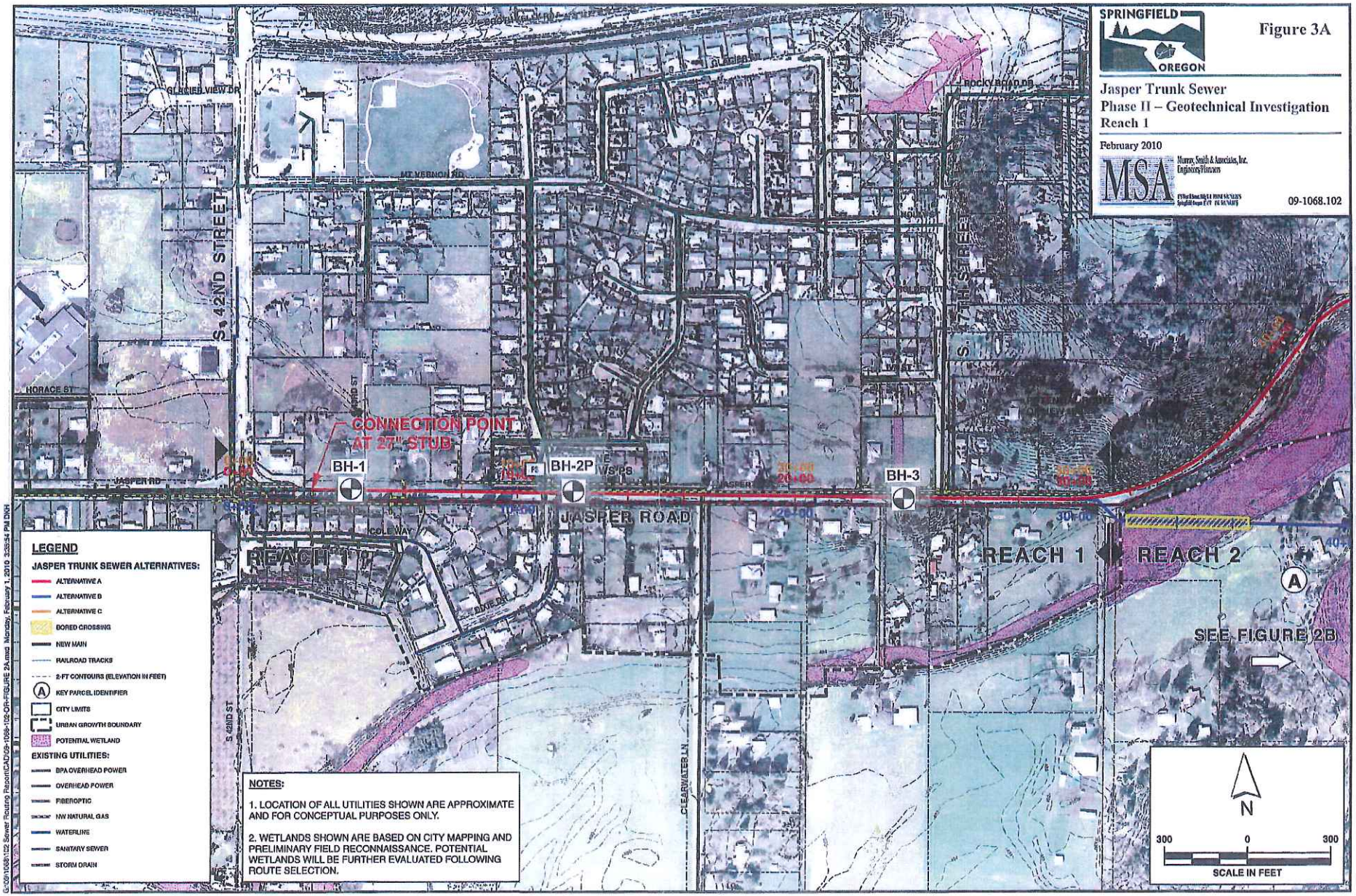
VICINITY MAP

JASPER TRUNK SEWER
SPRINGFIELD, OREGON

FIGURE NO.
1A

FILE NAME:


SPRINGFIELD
OREGON
Figure 2A
Jasper Trunk Sewer
Sewer Alignment Overview
February 2010
MSA
Murray, Smith & Associates, Inc.
Engineers/Planners
09-1068.102
REACH 1
REACH 2
REACH 3
REACH 4
REACH 5
ALT A
ALT B
ALT C
NEW MAIN
MT VERNON RD
JASPER ROAD
S 42ND ST
LUCERNE MEADOWS PS
JASPER MEADOWS PS
Middle Fork Willamette River
LEGEND
JASPER TRUNK SEWER ALTERNATIVES:
ALTERNATIVE A
ALTERNATIVE B
ALTERNATIVE C
NEW MAIN
CITY LIMITS
URBAN GROWTH BOUNDARY
POTENTIAL WETLAND
NOTE:
WETLANDS SHOWN ARE BASED ON CITY MAPPING AND PRELIMINARY FIELD RECONNAISSANCE. POTENTIAL WETLANDS WILL BE FURTHER EVALUATED FOLLOWING ROUTE SELECTION.
0
0.25
0.5
Miles
N


SPRINGFIELD OREGON
Figure 3A
Jasper Trunk Sewer
Phase II – Geotechnical Investigation
Reach 1
February 2010
MSA
Murray, Smith & Associates, Inc.
Engineers/Planners
09-1068.102
S. 42ND STREET
S. 47TH STREET
JASPER ROAD
JASPER RD
MT VERNON RD
GLACIER VIEW DR
ROCKY ROAD DR
HORACE ST
COLE WAY
DAVE ST
CLEARWATER LN
CONNECTION POINT AT 27" STUB
BH-1
BH-2P
BH-3
WS PS
REACH 1
REACH 1
REACH 2
SEE FIGURE 2B
LEGEND
JASPER TRUNK SEWER ALTERNATIVES:
ALTERNATIVE A
ALTERNATIVE B
ALTERNATIVE C
BORED CROSSING
NEW MAIN
RAILROAD TRACKS
2-FT CONTOURS (ELEVATION IN FEET)
KEY PARCEL IDENTIFIER
CITY LIMITS
URBAN GROWTH BOUNDARY
POTENTIAL WETLAND
EXISTING UTILITIES:
BPA OVERHEAD POWER
OVERHEAD POWER
FIBEROPTIC
NW NATURAL GAS
WATERLINE
SANITARY SEWER
STORM DRAIN
NOTES:
1. LOCATION OF ALL UTILITIES SHOWN ARE APPROXIMATE AND FOR CONCEPTUAL PURPOSES ONLY.
2. WETLANDS SHOWN ARE BASED ON CITY MAPPING AND PRELIMINARY FIELD RECONNAISSANCE. POTENTIAL WETLANDS WILL BE FURTHER EVALUATED FOLLOWING ROUTE SELECTION.
N
300
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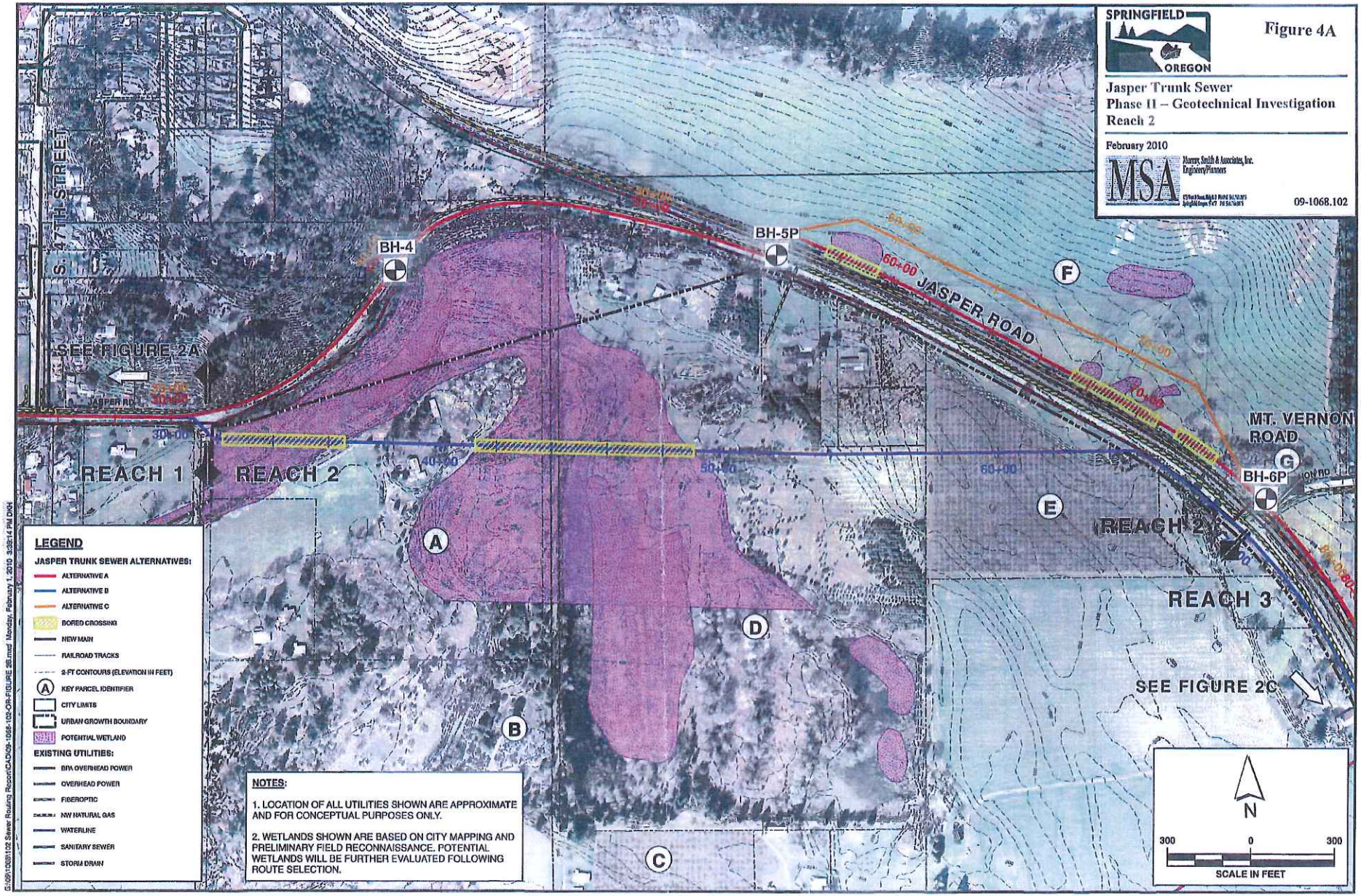
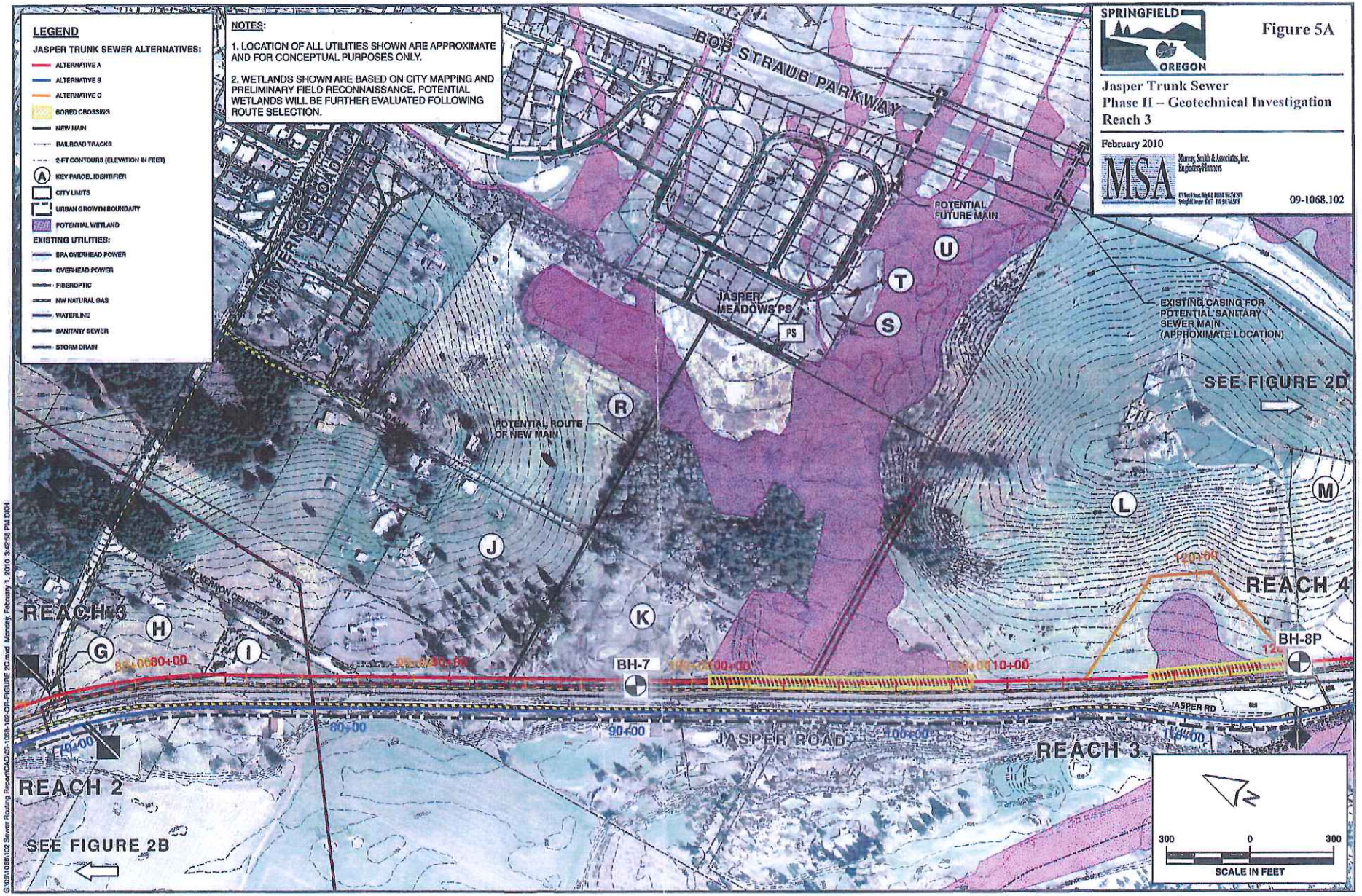
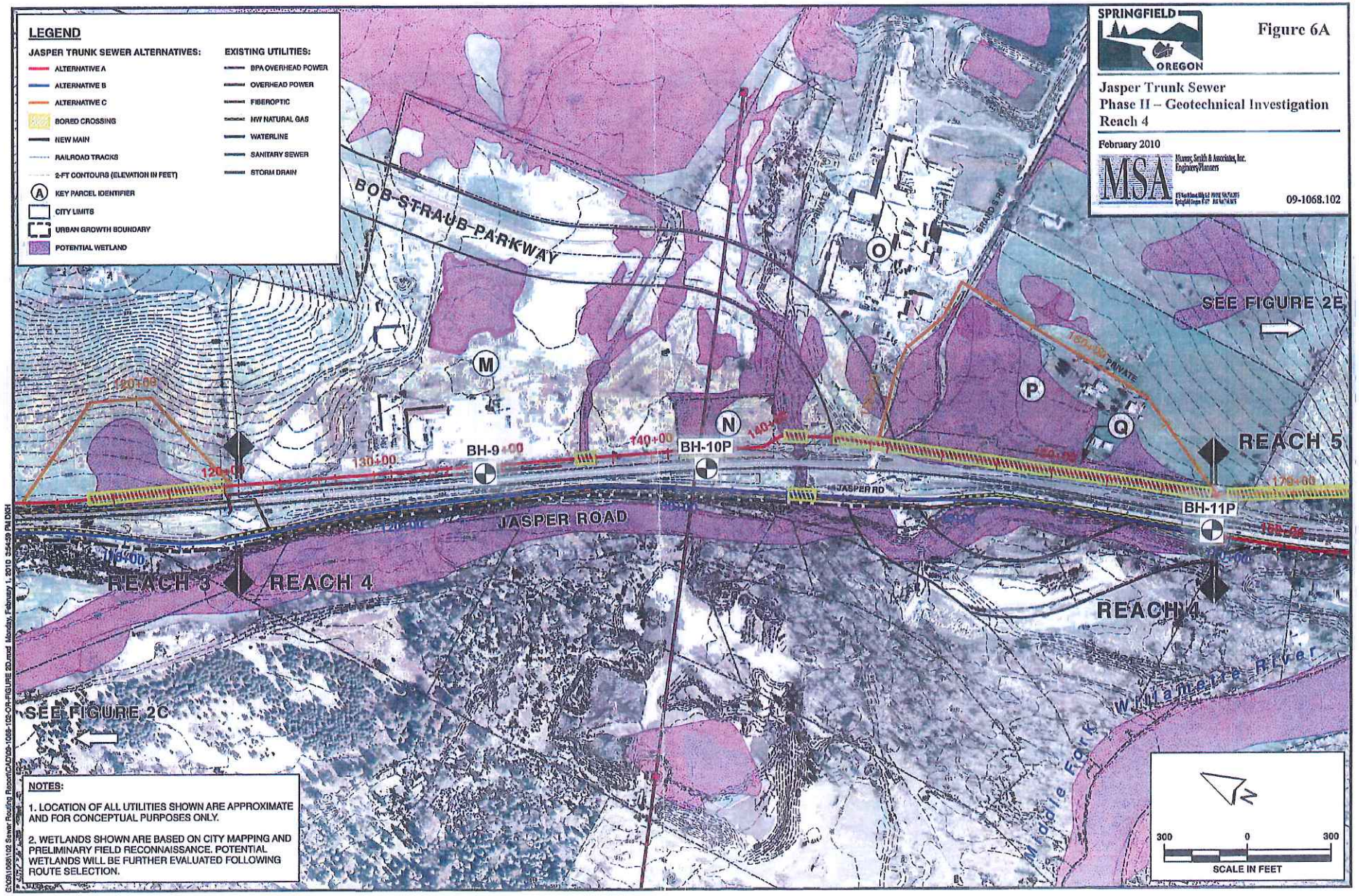
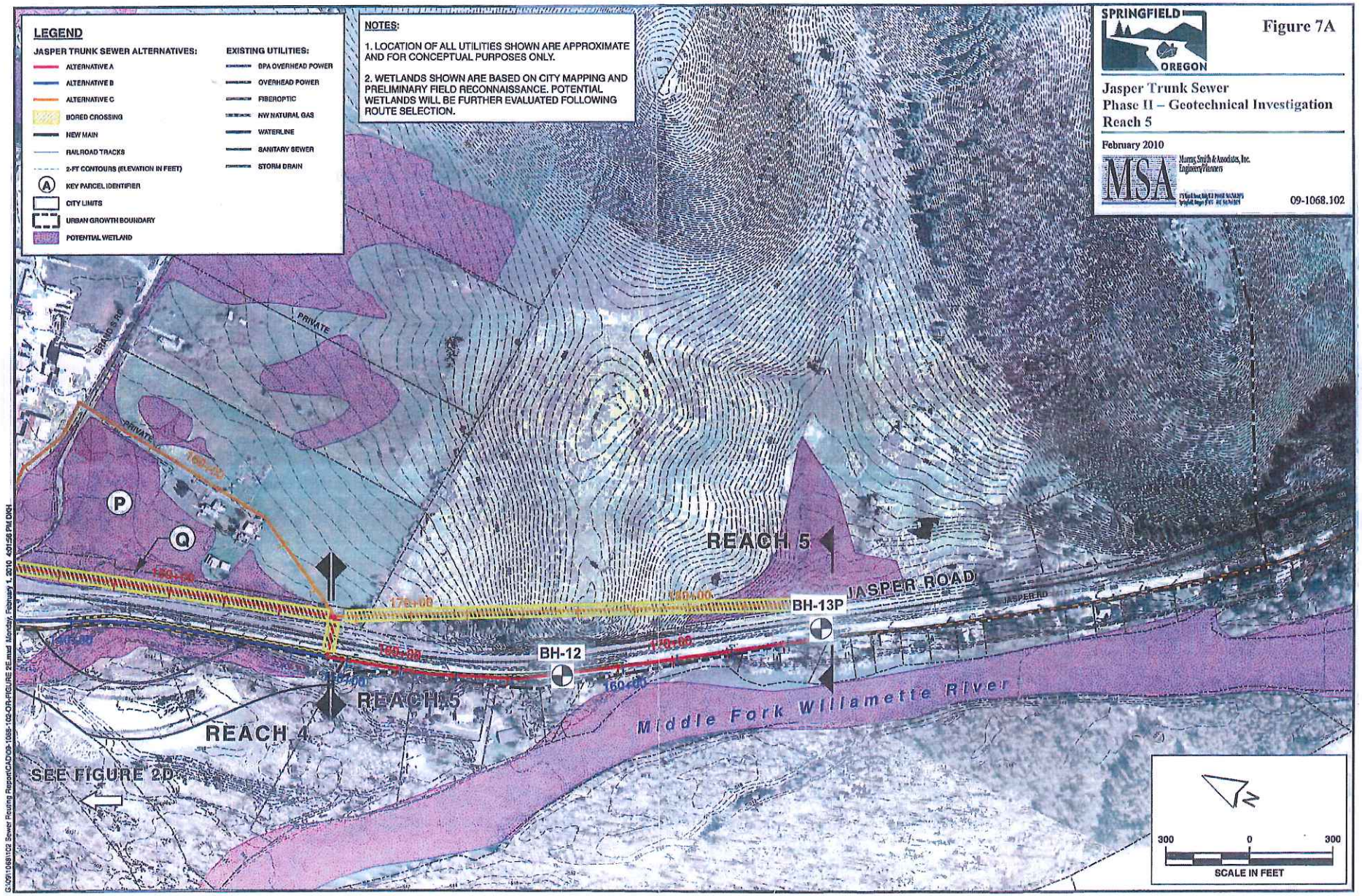
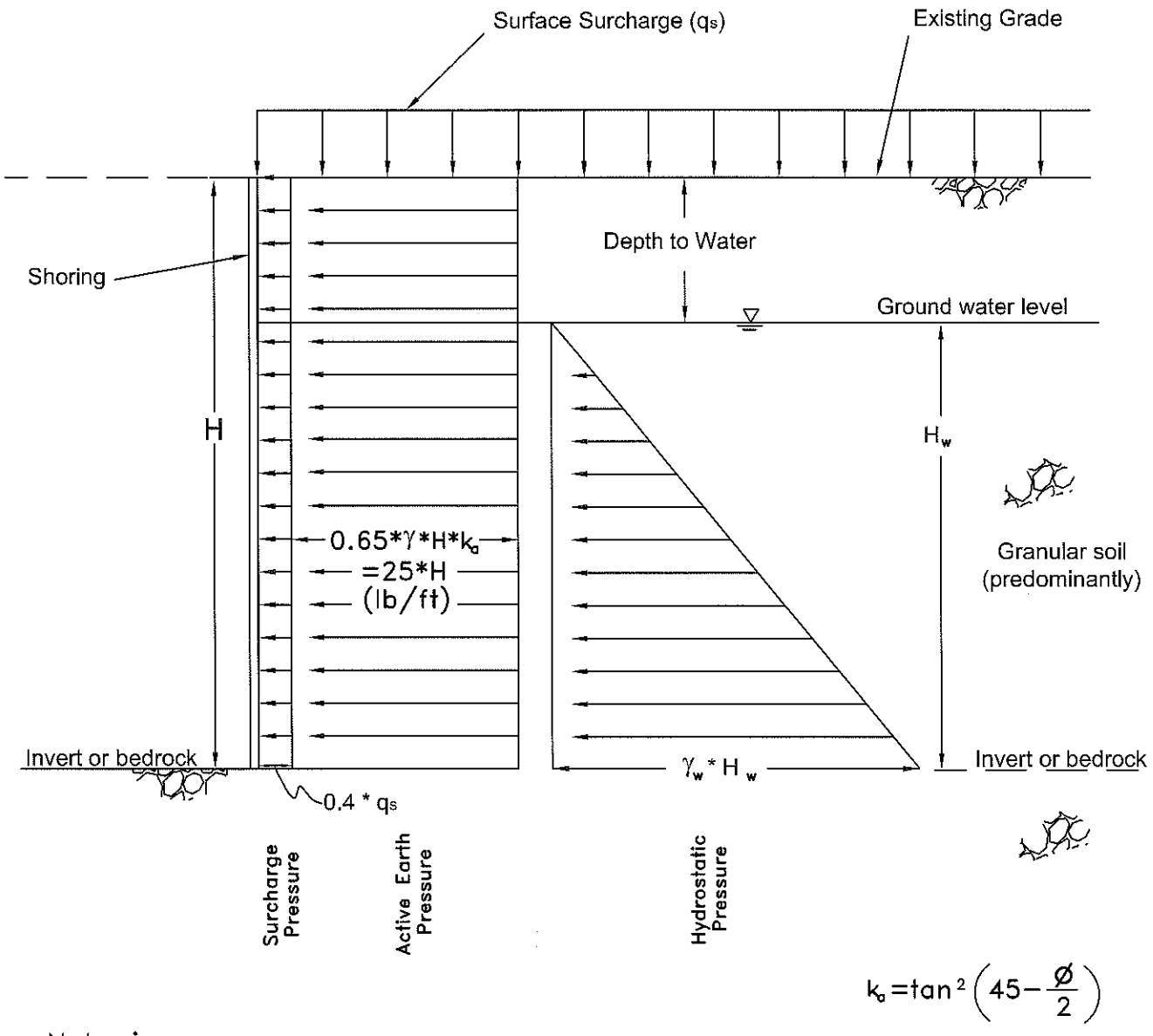
SCALE IN FEET


SPRINGFIELD
OREGON
Figure 4A
Jasper Trunk Sewer
Phase II – Geotechnical Investigation
Reach 2
February 2010
MSA
Murray, Smith & Associates, Inc.
Engineers/Planners
09-1068.102
BH-4
BH-5P
BH-6P
JASPER ROAD
MT. VERNON ROAD
S. 47TH STREET
SEE FIGURE 2A
SEE FIGURE 2C
REACH 1
REACH 2
REACH 3
A
B
C
D
E
F
G
LEGEND
JASPER TRUNK SEWER ALTERNATIVES:
ALTERNATIVE A
ALTERNATIVE B
ALTERNATIVE C
BORED CROSSING
NEW MAIN
RAILROAD TRACKS
2-FT CONTOURS (ELEVATION IN FEET)
KEY PARCEL IDENTIFIER
CITY LIMITS
URBAN GROWTH BOUNDARY
POTENTIAL WETLAND
EXISTING UTILITIES:
BPA OVERHEAD POWER
OVERHEAD POWER
FIBEROPTIC
NW NATURAL GAS
WATERLINE
SANITARY SEWER
STORM DRAIN
NOTES:
1. LOCATION OF ALL UTILITIES SHOWN ARE APPROXIMATE AND FOR CONCEPTUAL PURPOSES ONLY.
2. WETLANDS SHOWN ARE BASED ON CITY MAPPING AND PRELIMINARY FIELD RECONNAISSANCE. POTENTIAL WETLANDS WILL BE FURTHER EVALUATED FOLLOWING ROUTE SELECTION.
N
300
0
300
SCALE IN FEET


LEGEND
JASPER TRUNK SEWER ALTERNATIVES:
ALTERNATIVE A
ALTERNATIVE B
ALTERNATIVE C
BORED CROSSING
NEW MAIN
RAILROAD TRACKS
2-FT CONTOURS (ELEVATION IN FEET)
KEY PARCEL IDENTIFIER
CITY LIMITS
URBAN GROWTH BOUNDARY
POTENTIAL WETLAND
EXISTING UTILITIES:
BPA OVERHEAD POWER
OVERHEAD POWER
FIBEROPTIC
NW NATURAL GAS
WATERLINE
SANITARY SEWER
STORM DRAIN
NOTES:
1. LOCATION OF ALL UTILITIES SHOWN ARE APPROXIMATE AND FOR CONCEPTUAL PURPOSES ONLY.
2. WETLANDS SHOWN ARE BASED ON CITY MAPPING AND PRELIMINARY FIELD RECONNAISSANCE. POTENTIAL WETLANDS WILL BE FURTHER EVALUATED FOLLOWING ROUTE SELECTION.
SPRINGFIELD OREGON
Figure 5A
Jasper Trunk Sewer
Phase II – Geotechnical Investigation
Reach 3
February 2010
MSA Morrow, Smith & Associates, Inc. Engineers/Planners
09-1068.102
BOB STRAUB PARKWAY
VERNON ROAD
POTENTIAL FUTURE MAIN
JASPER MEADOWS PS
PS
EXISTING CASING FOR POTENTIAL SANITARY SEWER MAIN (APPROXIMATE LOCATION)
SEE FIGURE 2D
POTENTIAL ROUTE OF NEW MAIN
REACH 3
REACH 4
REACH 2
BH-7
BH-8P
JASPER ROAD
JASPER RD
SEE FIGURE 2B
300 0 300
SCALE IN FEET


LEGEND
JASPER TRUNK SEWER ALTERNATIVES:
ALTERNATIVE A
ALTERNATIVE B
ALTERNATIVE C
BORED CROSSING
NEW MAIN
RAILROAD TRACKS
2-FT CONTOURS (ELEVATION IN FEET)
KEY PARCEL IDENTIFIER
CITY LIMITS
URBAN GROWTH BOUNDARY
POTENTIAL WETLAND
EXISTING UTILITIES:
BPA OVERHEAD POWER
OVERHEAD POWER
FIBEROPTIC
NW NATURAL GAS
WATERLINE
SANITARY SEWER
STORM DRAIN
SPRINGFIELD
OREGON
Figure 6A
Jasper Trunk Sewer
Phase II – Geotechnical Investigation
Reach 4
February 2010
MSA
Murray, Smith & Associates, Inc.
Engineers/Planners
09-1068.102
BOB STRAUB PARKWAY
JASPER ROAD
JASPER RD
BRAND S RD
PRIVATE
SEE FIGURE 2E
SEE FIGURE 2C
REACH 3
REACH 4
REACH 5
REACH 4
BH-9P
BH-10P
BH-11P
M
N
O
P
Q
120+00
130+00
140+00
150+00
160+00
170+00
180+00
Middle Fork Willamette River
NOTES:
1. LOCATION OF ALL UTILITIES SHOWN ARE APPROXIMATE AND FOR CONCEPTUAL PURPOSES ONLY.
2. WETLANDS SHOWN ARE BASED ON CITY MAPPING AND PRELIMINARY FIELD RECONNAISSANCE. POTENTIAL WETLANDS WILL BE FURTHER EVALUATED FOLLOWING ROUTE SELECTION.
300
0
300
SCALE IN FEET


LEGEND
JASPER TRUNK SEWER ALTERNATIVES:
ALTERNATIVE A
ALTERNATIVE B
ALTERNATIVE C
BORED CROSSING
NEW MAIN
RAILROAD TRACKS
2-FT CONTOURS (ELEVATION IN FEET)
KEY PARCEL IDENTIFIER
CITY LIMITS
URBAN GROWTH BOUNDARY
POTENTIAL WETLAND
EXISTING UTILITIES:
BPA OVERHEAD POWER
OVERHEAD POWER
FIBEROPTIC
NW NATURAL GAS
WATERLINE
SANITARY SEWER
STORM DRAIN
NOTES:
1. LOCATION OF ALL UTILITIES SHOWN ARE APPROXIMATE AND FOR CONCEPTUAL PURPOSES ONLY.
2. WETLANDS SHOWN ARE BASED ON CITY MAPPING AND PRELIMINARY FIELD RECONNAISSANCE. POTENTIAL WETLANDS WILL BE FURTHER EVALUATED FOLLOWING ROUTE SELECTION.
SPRINGFIELD OREGON
Figure 7A
Jasper Trunk Sewer
Phase II – Geotechnical Investigation
Reach 5
February 2010
MSA Murray, Smith & Associates, Inc. Engineers/Planners
09-1068.102
PRIVATE
BRAND S RD
PRIVATE
P
Q
REACH 5
JASPER ROAD
JASPER RD
BH-13P
BH-12
REACH 5
REACH 4
Middle Fork Willamette River
SEE FIGURE 2D
N
300
0
300
SCALE IN FEET



$$k_a = \tan^2\left(45 - \frac{\phi}{2}\right)$$

Notes:

1. The ground water level shown above is conceptual only. Actual water level to be confirmed at time of construction.
2. Design pressures should be calculated based on the actual shoring and ground water depths (see report).

DATE JUNE 2010
DWN. EJG
APPR.
REVIS.
PROJECT NO.
2091089-101

FOUNDATION ENGINEERING INC.
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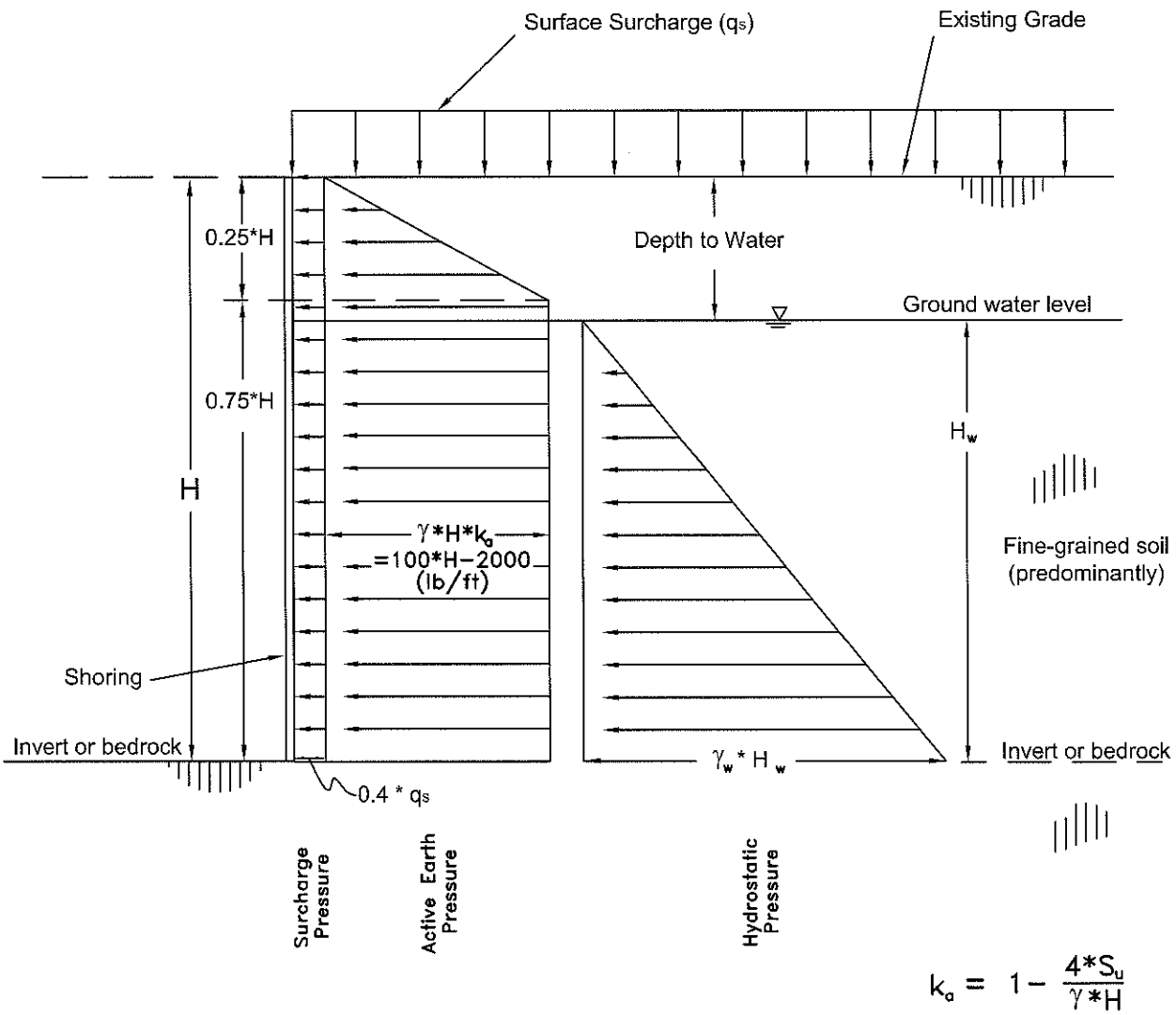
SHORING PRESSURES FOR GRANULAR SOIL PROFILE
JASPER TRUNK SEWER
SPRINGFIELD, OREGON

FIGURE NO.
8A

FILE NAME:



$$k_a = 1 - \frac{4*S_u}{\gamma*H}$$

Notes:

1. The ground water level shown above is conceptual only. Actual water level to be confirmed at time of construction.
2. Design pressures should be calculated based on the actual shoring and ground water depths (see report).

DATE JUNE 2010
DWN. EJG
APPR.
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2091089−101

FOUNDATION ENGINEERING INC.
PROFESSIONAL GEOTECHNICAL SERVICES
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SHORING PRESSURES
FOR FINE-GRAINED SOIL PROFILE
JASPER TRUNK SEWER
SPRINGFIELD, OREGON

FIGURE NO.
9A

FILE NAME:

Appendix B

Boring Logs and Rock Core Photos

Professional Geotechnical Services

Foundation Engineering, Inc.

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 laboratory examinations and tests. Our recommendations are based on the contents of the final logs and the information contained therein and not on the field logs.

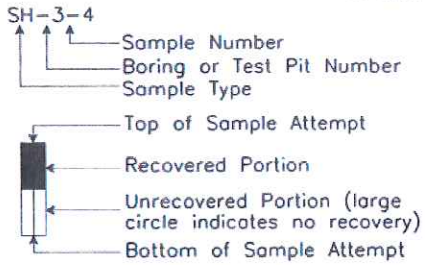
VARIATION IN SOILS BETWEEN TEST PITS AND BORINGS

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



S – Grab Samples
SS – Standard Penetration Test Sample (split-spoon)
SH – Thin-walled Shelby Tube Sample
C – Core Sample
CS – Continuous Sample

▲ 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 (%).

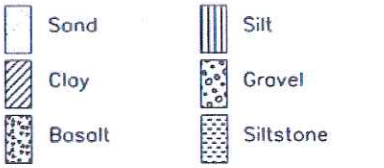
UNIFIED SOIL CLASSIFICATION SYMBOLS

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 pocket penetrometer devices.

TYPICAL SOIL/ROCK SYMBOLS



WATER TABLE

Water Table Location

(1/31/00) Date of Measurement

Piezometer Tip Location (if used)

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SYMBOL KEY
BORING AND TEST PIT 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 – 1	< 0.125	Very Soft	0 – 4	Very Loose
Easily penetrated several inches by thumb.	2 – 4	0.125–0.25	Soft	5 – 10	Loose
Can be penetrated several inches by thumb with moderate effort.	5 – 8	0.25 – 0.50	Medium Stiff (Firm)	11 – 30	Medium Dense
Readily indented by thumb but penetrated only with great effort.	9 – 15	0.50 – 1.0	Stiff	31 – 50	Dense
Readily indented by thumbnail.	16 – 30	1.0 – 2.0	Very Stiff	> 50	Very Dense
Indented with difficulty by thumbnail.	31 – 60	> 2.0	Hard		

* 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 silt/clay can be readily remolded. Soil leaves wetness on the hand when squeezed. "Wet" indicates that the soil is wetter than the optimum moisture content and above the plastic limit.

Term	PI	Plasticity Field Test
Nonplastic	0 – 3	Cannot be rolled into a thread.
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 rerolled into thread.

Term	Soil Structure Criteria
Stratified	Alternating layers at least 1 inch thick – describe variation.
Laminated	Alternating layers at less than 1 inch thick – describe variation.
Fissured	Contains shears and partings along planes of weakness.
Slickensides	Partings appear glossy or striated.
Blocky	Breaks into lumps – crumbly.
Lensed	Contains pockets of different soils – describe variation.

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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COMMON TERMS
SOIL DESCRIPTIONS

Explanation of Common Terms Used in Rock Descriptions

Field Identification		UCS (psi)	UCS (MPa)	Strength (Hardness)
Indented by thumbnail.	R0	< 100	0.25–1.0	Extremely Weak (Extremely Soft)
Crumbles under firm blows with geological hammer, can be peeled by a pocket knife.	R1	100–1000	1.0–5.0	Very Weak (Very Soft)
Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with geological hammer.	R2	1000–4000	5.0–25	Weak (Soft)
Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single blow of geological hammer.	R3	4000–8000	25–50	Medium Strong (Medium Hard)
Specimen requires more than one blow of geological hammer to fracture it.	R4	8000–16000	50–100	Strong (Hard)
Specimen requires many blows of geological hammer to fracture it.	R5	16000–36000	100–250	Very Strong (Very Hard)
Specimen can only be chipped with geological hammer.	R6	> 36000	> 250	Extremely Strong (Extremely Hard)

Term	Weathering Field Identification
Fresh	Crystals are bright. Discontinuities may show some minor surface staining. No discoloration in rock fabric.
Slightly Weathered	Rock mass is generally fresh. Discontinuities are stained and may contain clay. Some discoloration in rock fabric.
Moderately Weathered	Significant portions of rock show discoloration and weathering effects. Crystals are dull and show visible chemical alteration. Discontinuities are stained and may contain secondary mineral deposits.
Highly Weathered	Rock can be excavated with geologist's pick. All dicontinuities exhibit secondary mineralization. Complete discoloration of rock fabric. Surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water.
Decomposed	Rock mass is completely decomposed. Original rock "fabric" may be evident. May be reduced to soil with hand pressure.

Spacing (meters)	Spacing (feet)	Spacing Term	Bedding/Foliation
< 0.06	< 2 in.	Very Close	Very Thin
0.06 – 0.30	2 in. – 1 ft.	Close	Thin
0.30 – 0.90	1 ft. – 3 ft.	Moderately Close	Medium
0.90 – 3.0	3 ft. – 10 ft.	Wide	Thick
> 3.0	> 10 ft.	Very Wide	Very Thick (Massive)

Vesicle Term	Volume
Some	3 – 20%
Highly	20 – 50%
Scoria	> 50%

Stratification Term	Description
Lamination	<0.39 in. thick beds
Fissile	Preferred break along laminations
Parting	Preferred break direction
Foliation	Metamorphic layering of minerals

RQD %	Designation	RQD %	Designation
0 – 25	Very Poor	75 – 90	Good
25 – 50	Poor	90 – 100	Excellent
50 – 75	Fair		

Rock Quality Designation (RQD) is the percent of a core run with intact lengths greater than 4.0 in. excluding breaks caused by drilling.

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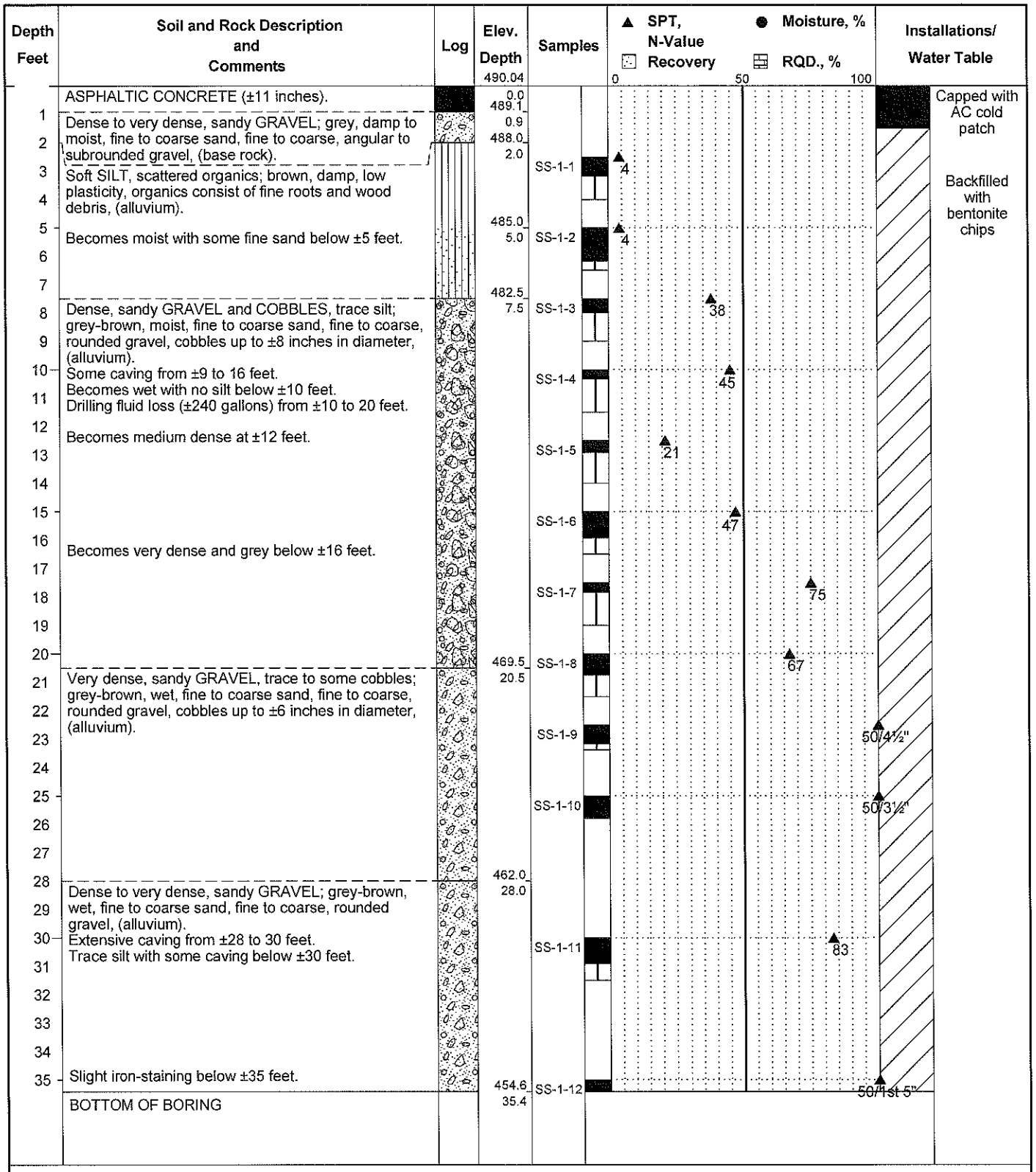
COMMON TERMS
ROCK DESCRIPTIONS



Project No.: 2091089-101

Surface Elevation: 490.04 feet (Approx.)

Date of Boring: March 22, 2010

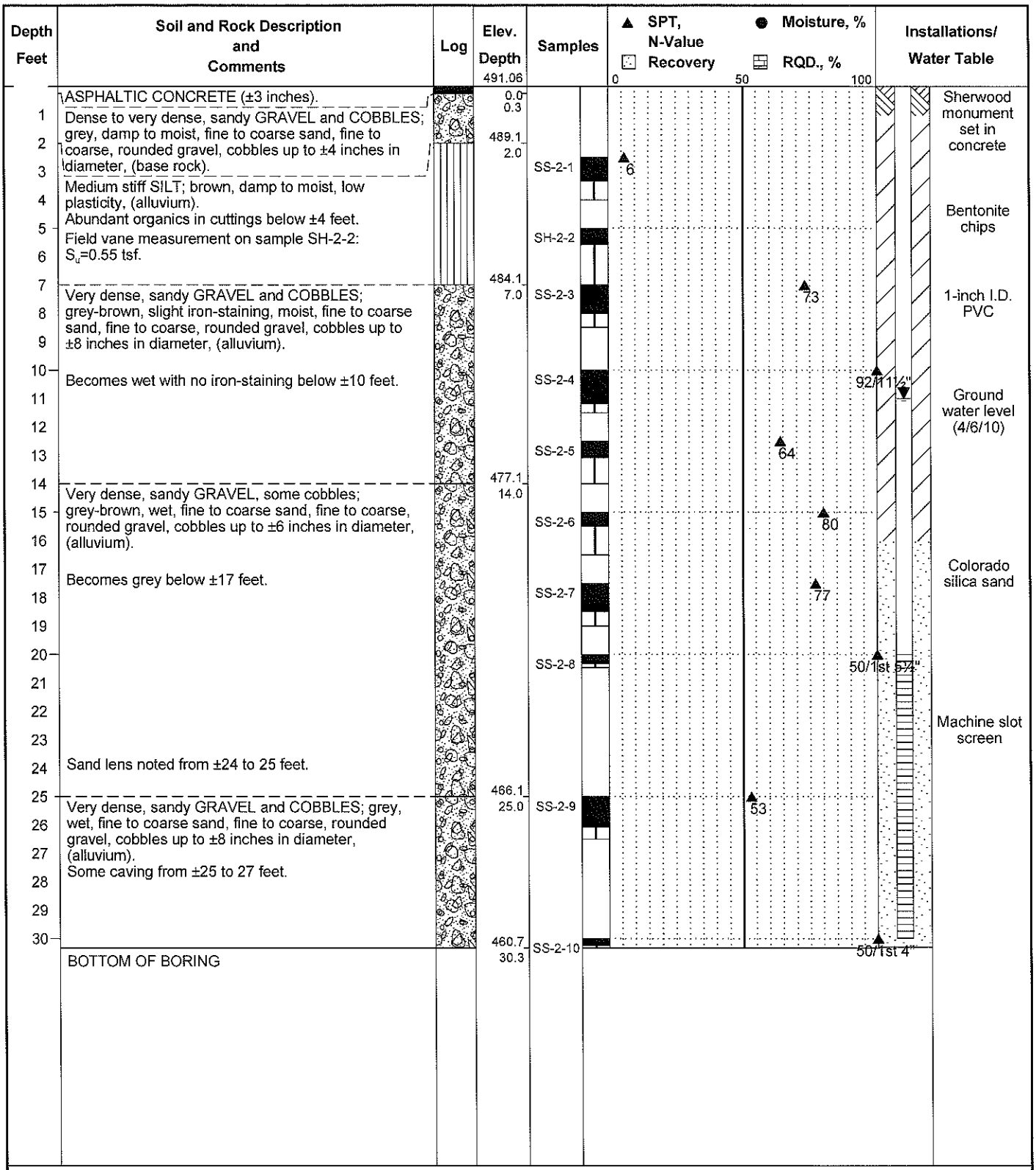
Boring Log: BH- 1

Jasper Trunk Sewer

Springfield, Oregon

Foundation Engineering, Inc.

Page 1 of 1



Project No.: 2091089-101

Surface Elevation: 491.06 feet (Approx.)

Date of Boring: March 23, 2010

Boring Log: BH- 2p

Jasper Trunk Sewer

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Page 1 of 1

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth 499.68	Samples	▲ SPT, N-Value ● Moisture, % ▨ Recovery ⊞ RQD., % (0 – 50 – 100)	Installations/ Water Table
	ASPHALTIC CONCRETE (±11 inches).		0.0 / 498.8			Capped with AC cold patch
1–3	Very dense, sandy GRAVEL, some silt; grey-brown, slightly iron-stained, damp, low plasticity silt, fine to coarse sand, fine to coarse, angular to rounded gravel, (possible fill).		0.9 / 496.2	SS-3-1		Backfilled with bentonite chips
4–7	Hard SILT; brown, damp, non-plastic, (residual soil).		3.5 / 492.2	SS-3-2	81/9"	
8–9	Very dense, silty ROCK FRAGMENTS; grey-brown, slightly iron-stained, damp, low plasticity silt, fine sand to coarse, gravel-sized, basaltic rock fragments, (residual soil).		7.5 / 490.7	SS-3-3	71	
10–24	Weak (R2) BASALT; dark grey, slightly to moderately weathered, (Oligocene Basalt). Becomes medium strong (R3) and slightly weathered with close joints, joints are irregular, rough to very rough, open to closed, some healed to calcite mineralized below ±15 feet. Angular (±70°) joints from ±17 to 22 feet.		9.0	SS-3-4	50/1st 3½"	
				CS-3-1		
				CS-3-2		
				CS-3-3		
25	BOTTOM OF BORING		474.7 / 25.0			

Project No.: 2091089-101

Surface Elevation: 499.68 feet (Approx.)

Date of Boring: March 23, 2010

Boring Log: BH- 3

Jasper Trunk Sewer

Springfield, Oregon

Foundation Engineering, Inc.

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth 509.14	Samples	SPT, N-Value / Recovery / Moisture, % / RQD., % (0 – 50 – 100)	Installations/ Water Table
	ASPHALTIC CONCRETE (±11 inches).		0.0			Capped with AC cold patch
1	Dense to very dense, CRUSHED ROCK; grey, damp, fine to coarse sand, fine to coarse, angular to subrounded, (base rock).		508.2 0.9			
2			507.1 2.0			
3	Medium dense to dense ROCK FRAGMENTS, some silt; grey, damp to moist, low to medium plasticity silt, fine, sand to cobble-sized, basaltic rock fragments, (residual soil).			SS-4-1	▲ 42	
4						
5				SS-4-2	▲ 21	Backfilled with bentonite chips
6						
7			502.1 7.0			
8	Medium strong to strong (R3 to R4) BASALT; brown to grey, highly to moderately weathered, close joints, joints are irregular, rough to very rough, open to closed, some healed to calcite mineralized, (Oligocene Basalt).			CS-4-1		
9						
10						
11				CS-4-2		
12	Highly fractured and no recovery zones from ±12 to 15.5 and 17.4 to 21 feet.					
13						
14						
15						
16				CS-4-3		
17						
18						
19				CS-4-4		
20						
21			488.1 21.0			
	BOTTOM OF BORING					

Project No.: 2091089-101

Surface Elevation: 509.14 feet (Approx.)

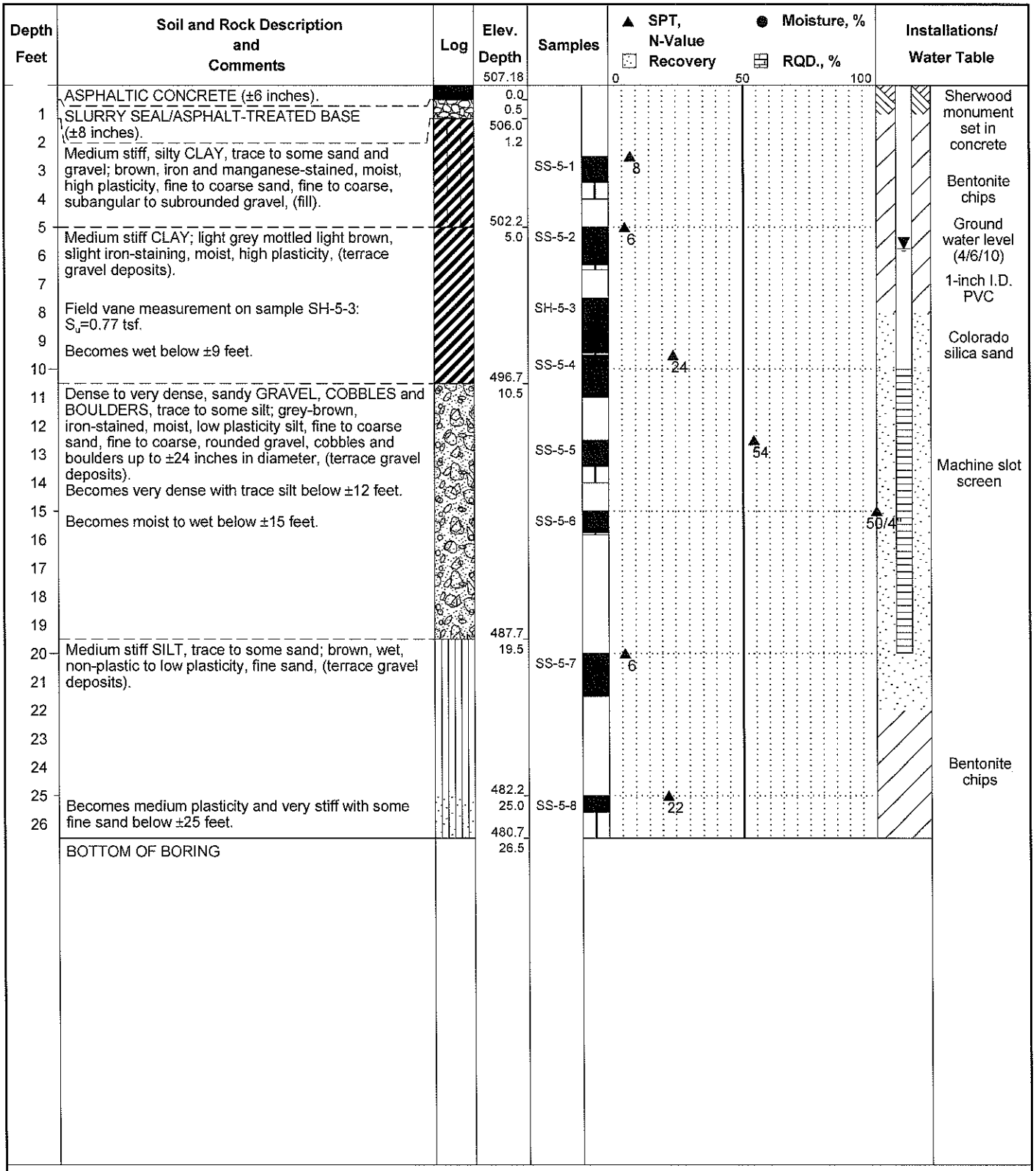
Date of Boring: March 24, 2010

Boring Log: BH- 4

Jasper Trunk Sewer

Springfield, Oregon

Foundation Engineering, Inc.



Project No.: 2091089-101

Surface Elevation: 507.18 feet (Approx.)

Date of Boring: March 24, 2010

Boring Log: BH- 5p

Jasper Trunk Sewer

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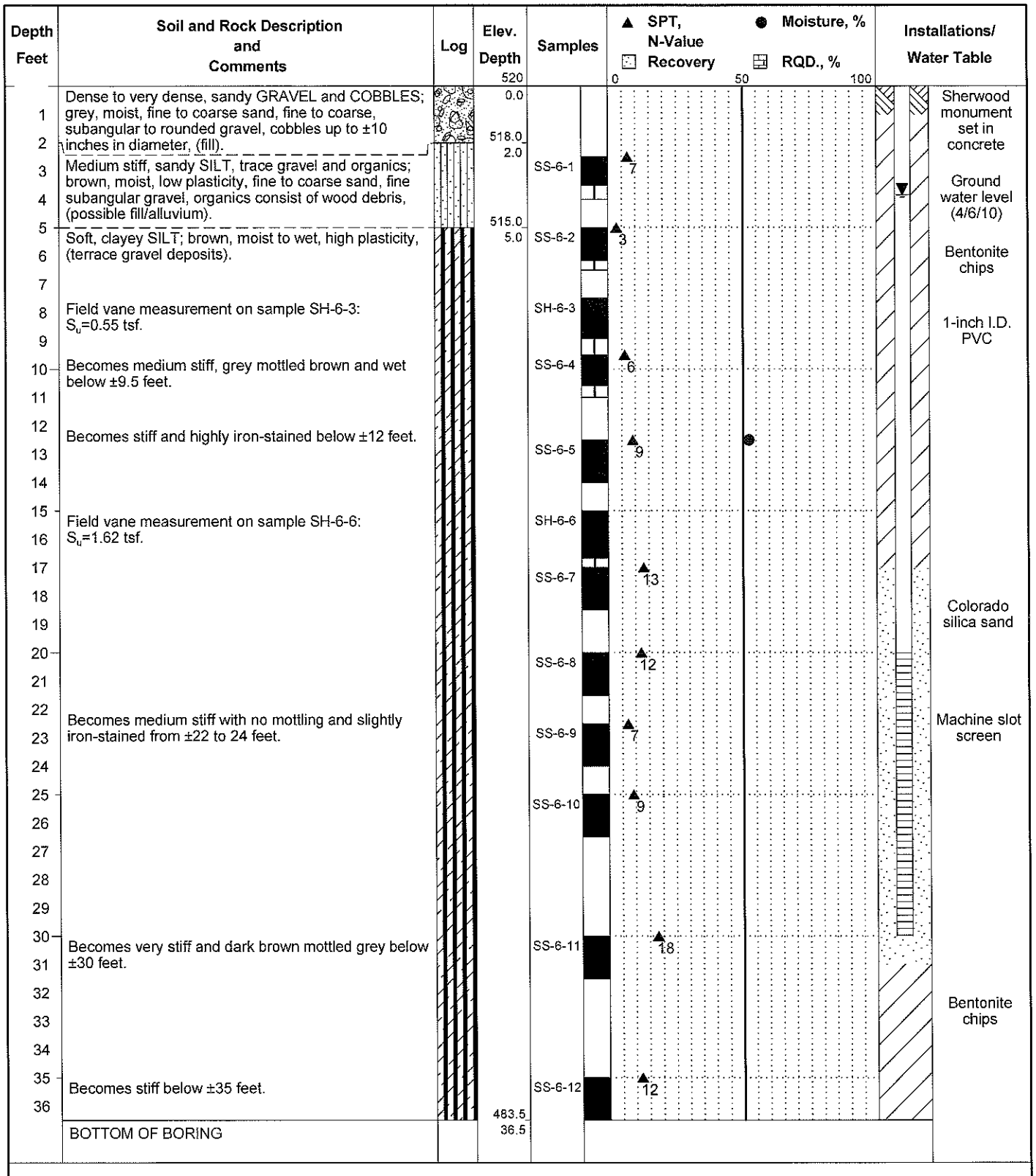
Page 1 of 1



Project No.: 2091089-101

Surface Elevation: 520.00 feet (Approx.)

Date of Boring: March 23, 2010

Boring Log: BH- 6p

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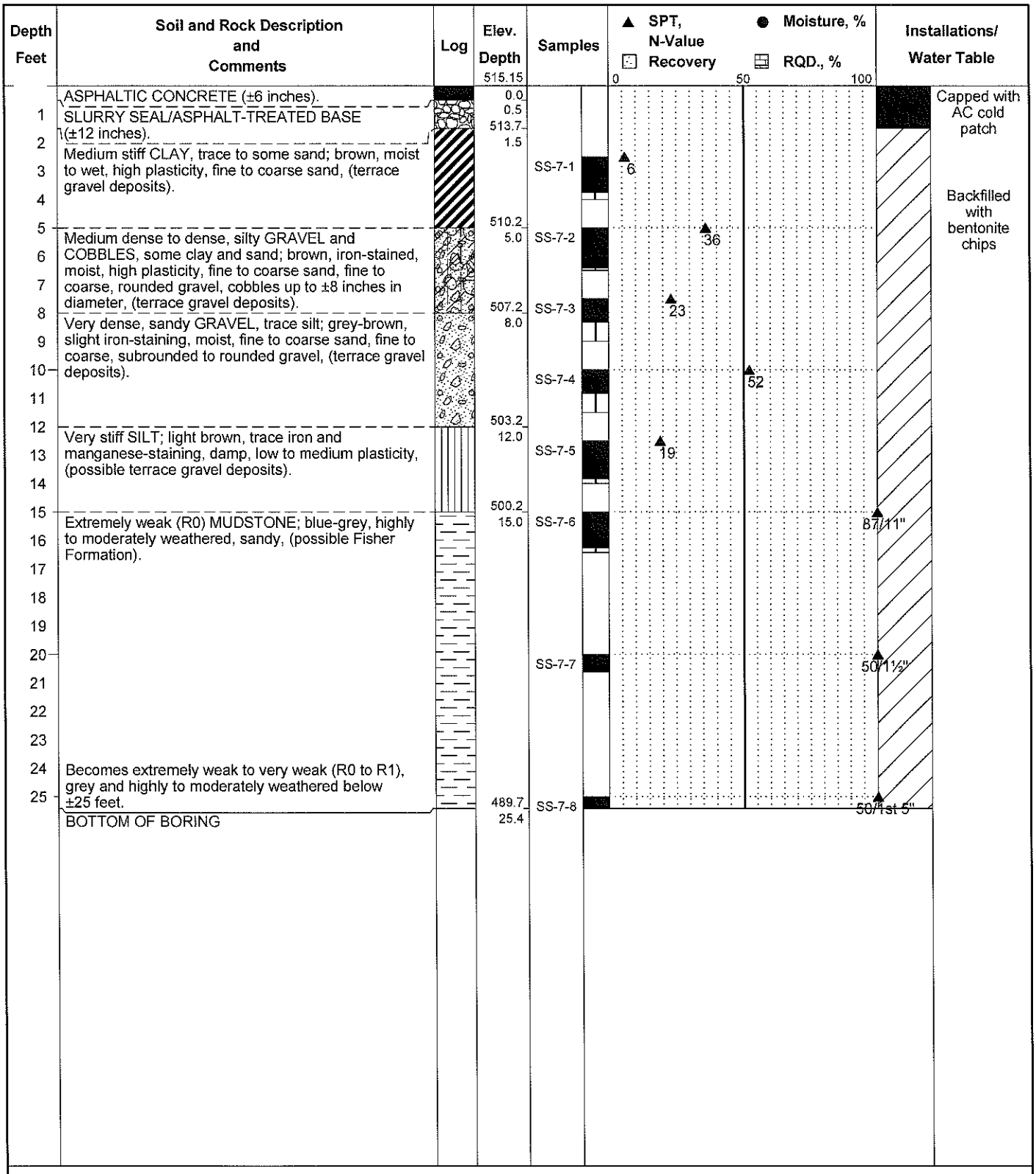
Page 1 of 1



Project No.: 2091089-101

Surface Elevation: 515.15 feet (Approx.)

Date of Boring: March 24, 2010

Boring Log: BH- 7

Jasper Trunk Sewer

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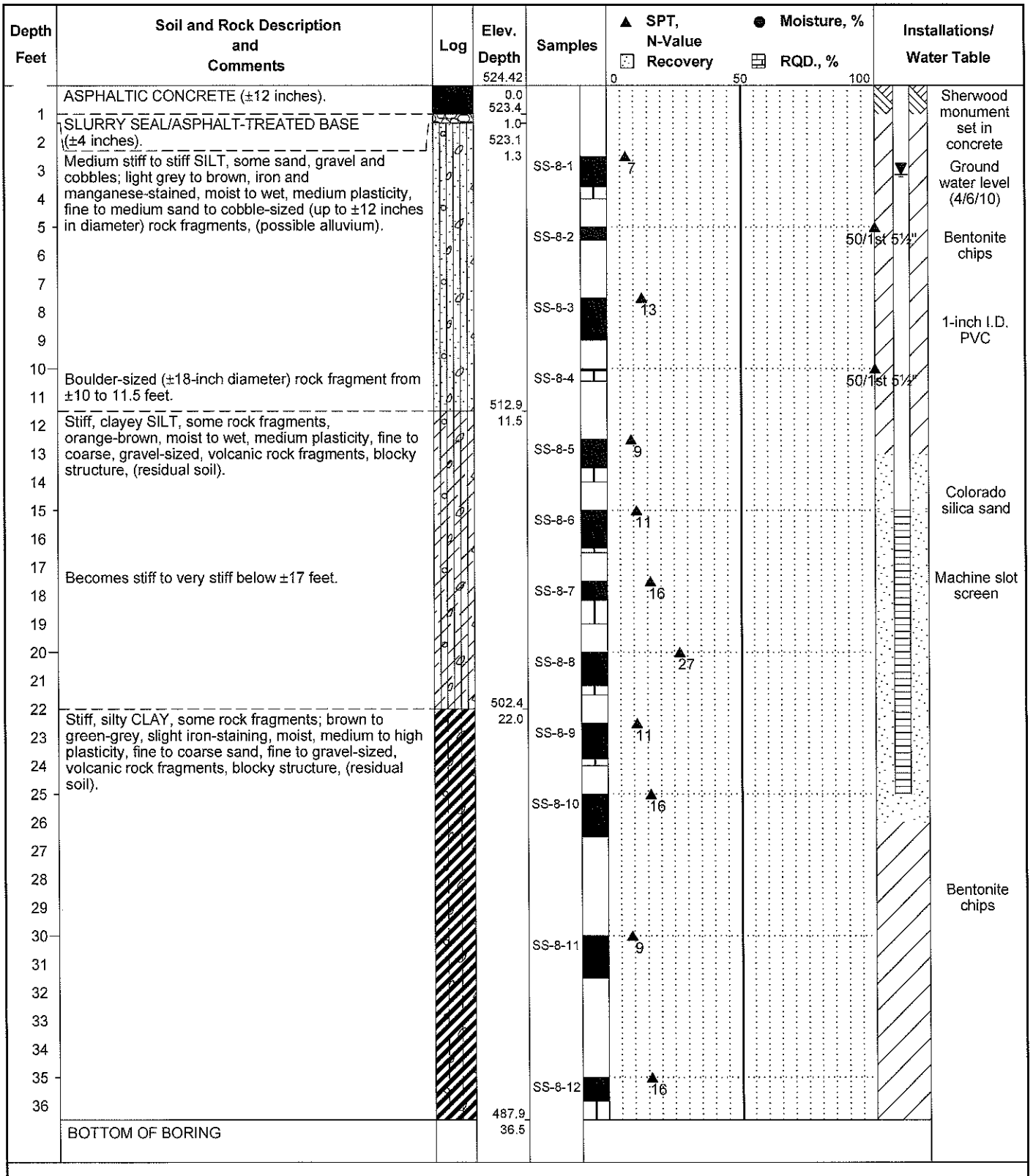

Project No.: 2091089-101

Surface Elevation: 524.42 feet (Approx.)

Date of Boring: March 25, 2010

Boring Log: BH- 8p

Jasper Trunk Sewer

Springfield, Oregon

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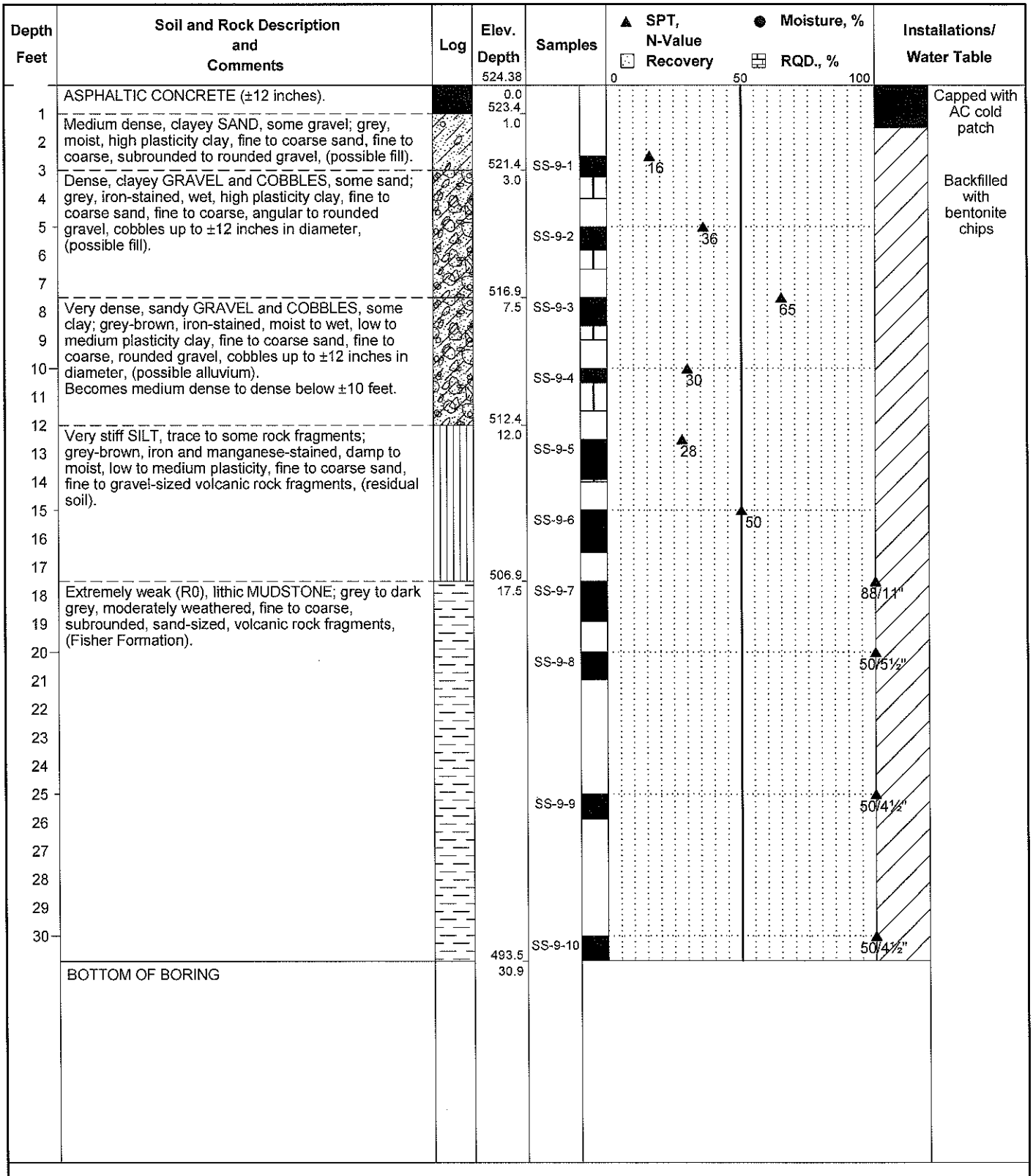

Project No.: 2091089-101

Surface Elevation: 524.38 feet (Approx.)

Date of Boring: March 25, 2010

Boring Log: BH- 9

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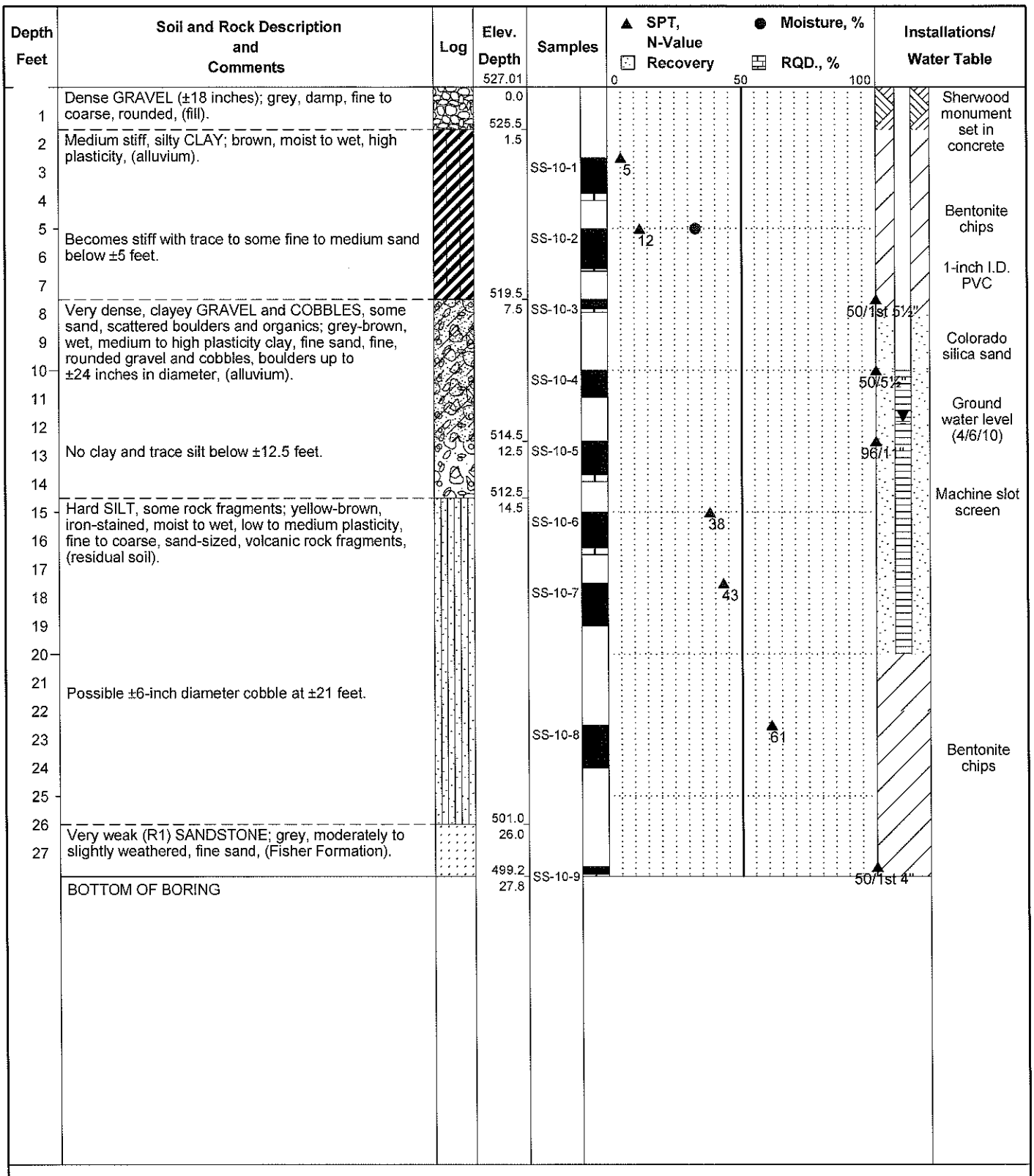

Project No.: 2091089-101

Surface Elevation: 527.01 feet (Approx.)

Date of Boring: March 27, 2010

Boring Log: BH-10p

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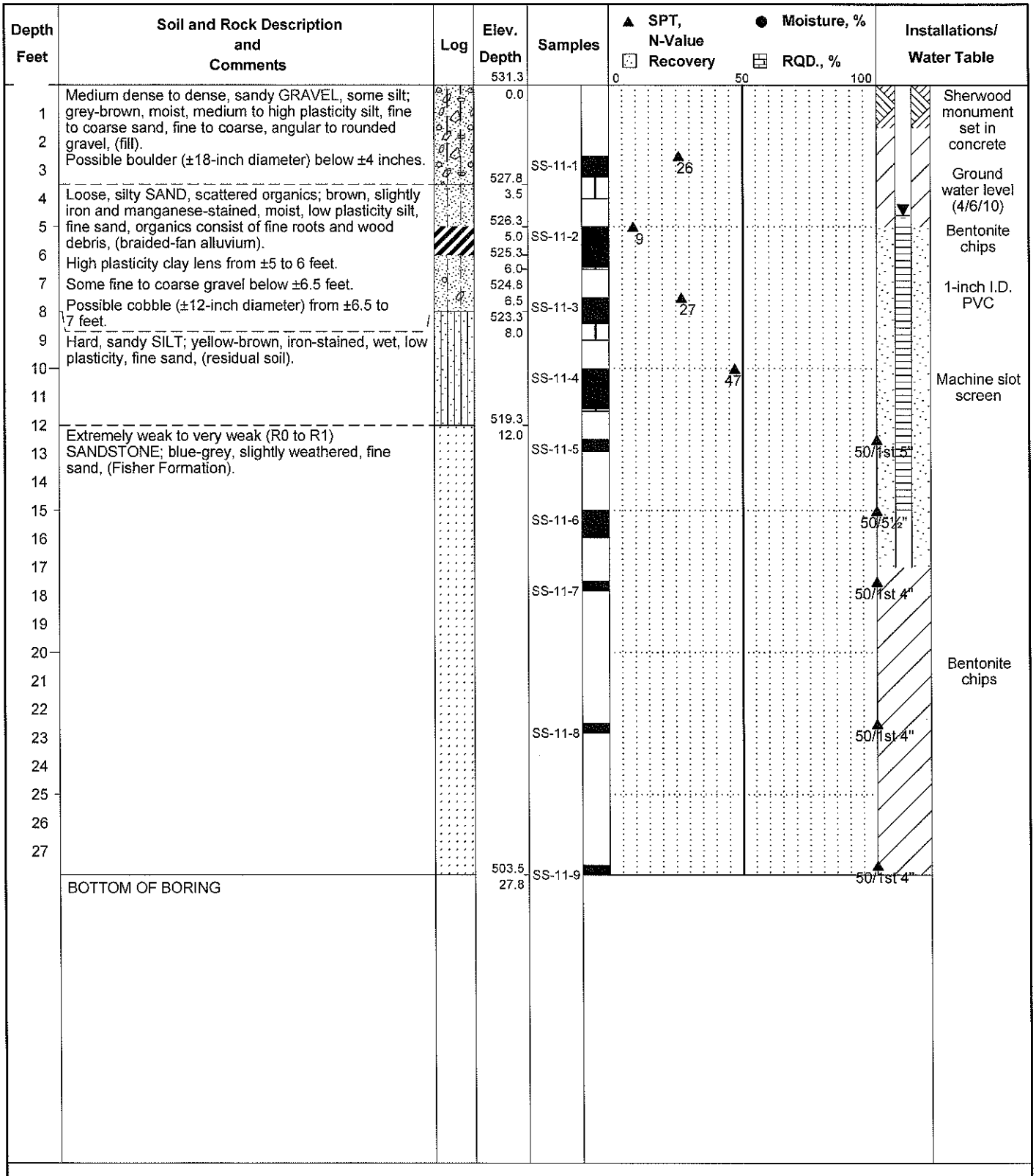
Page 1 of 1



Project No.: 2091089-101

Surface Elevation: 531.30 feet (Approx.)

Date of Boring: March 26, 2010

Boring Log: BH-11p

Jasper Trunk Sewer

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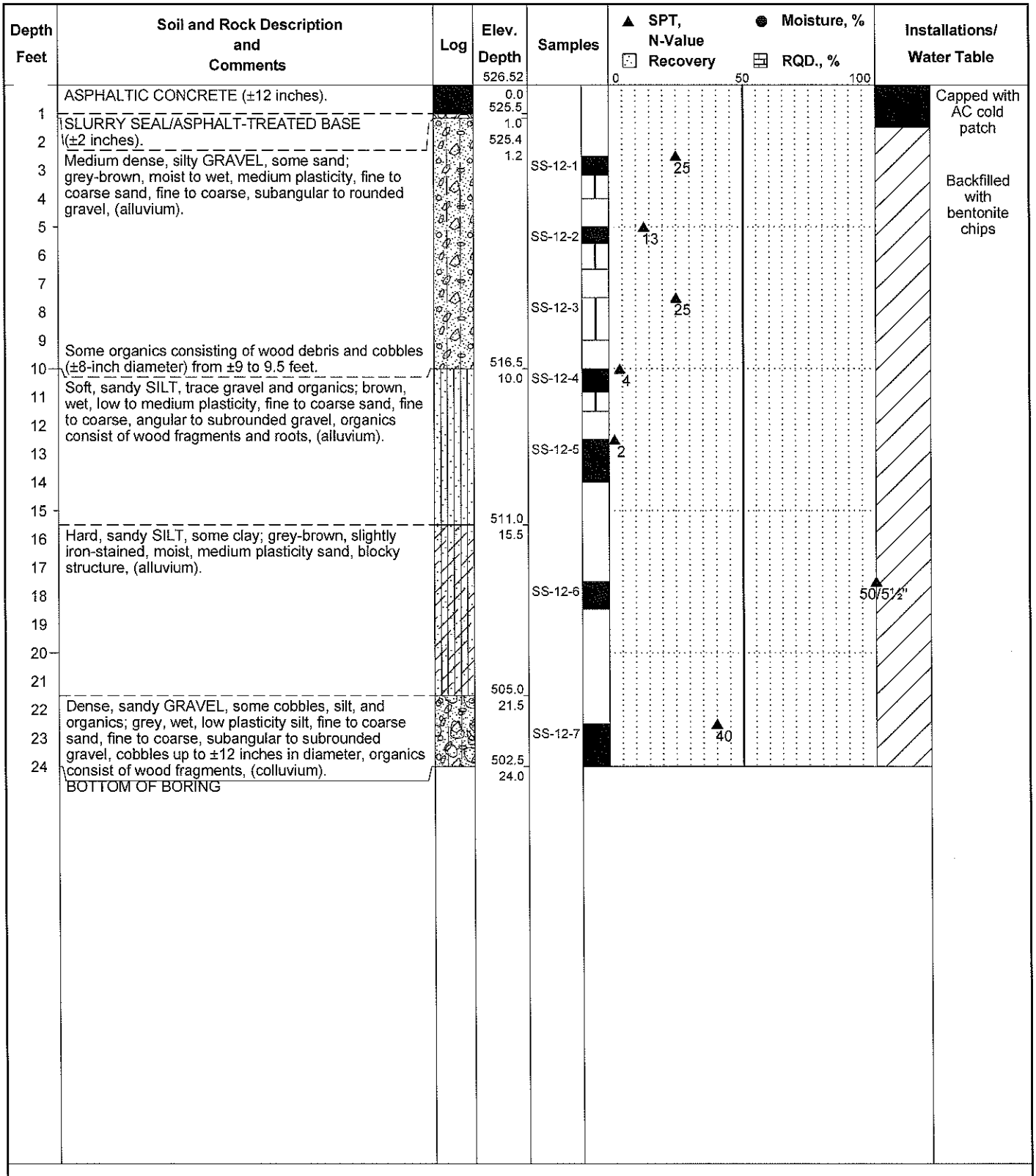
Page 1 of 1



Project No.: 2091089-101

Surface Elevation: 526.52 feet (Approx.)

Date of Boring: March 26, 2010

Boring Log: BH-12

Jasper Trunk Sewer

Springfield, Oregon

Foundation Engineering, Inc.

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth	Samples	▲ SPT, N-Value ● Moisture, % ⊡ Recovery ⊞ RQD., % (0 — 50 — 100)	Installations/ Water Table
			526.41			
1	ASPHALTIC CONCRETE (±12 inches).		0.0			Sherwood monument set in concrete
			525.4			
2	SLURRY SEAL/ASPHALT-TREATED BASE (±3 inches).		1.0			
			525.2			
3	Medium stiff, clayey SILT, trace sand and gravel; brown, moist to wet, high grading to medium plasticity, fine sand, fine, rounded gravel, (alluvium).		1.3	SS-13-1	▲ 5	Bentonite chips
4						
5	Field vane measurement on sample SH-13-3: S_u=0.8 tsf.			SS-13-2	▲ 5 ●	±1-inch I.D. PVC
6						Colorado silica sand
7						
8				SH-13-3		Ground water level (4/6/10)
9						
10			516.4	SS-13-4	▲ 13	
	Stiff, sandy SILT, trace to some gravel; brown, slight iron-staining, wet, low to medium plasticity, fine to coarse sand, fine, rounded gravel, (alluvium). Scattered cobbles (±4-inch diameter) from ±11 to 12 feet.		10.0			
11						
12			513.9			Machine slot screen
13	Extremely weak (R0), lithic SANDSTONE; blue-grey to dark grey, highly to moderately weathered, fine, subrounded, sand-sized, volcanic rock fragments, muddy, (Fisher Formation).		12.5	SS-13-5	▲ 50/3½"	
14						
15						
16						
17						
18				SS-13-6	▲ 50/4"	
	BOTTOM OF BORING		508.1			
			18.3			

Project No.: 2091089-101

Surface Elevation: 526.41 feet (Approx.)

Date of Boring: March 26, 2010

Boring Log: BH-13p

Jasper Trunk Sewer

Springfield, Oregon

Foundation Engineering, Inc.

Photo 1. BH-3 Box 1

Photo 2. BH-3 Box 2

Photo 3. BH-4 Box 1

Photo 4. BH-4 Box 2

Appendix C

Field and Laboratory Test Results

Professional Geotechnical Services

Foundation Engineering, Inc.

Table 1C. Natural Water Contents, Atterberg Limits, and Unconfined Compression Test Results

Sample Number	Sample Depth (feet)	Moisture Content (percent)	LL	PL	PI	USCS Classification	Unconfined Compressive Strength (psi)
CS-3-1	15.1 – 15.6						5,416
CS-4-1	9.2 – 10.0						10,085
CS-4-2	14.6 – 15.1						7,010
SS-6p-5	12.5 – 14.0	52.3	95	43	52	MH	
SS-10p-2	5.0 – 6.5	32.8	68	32	36	CH	
SS-13p-2	5.0 – 6.5	41.8	52	37	15	MH	

Table 2C. Summary of Resistivity Testing

Location	Pin Spacing (ft.)	Resistivity (Ω-cm)
R-1	10	15,129
	20	19,916
	30	20,682
R-2	15	16,948
	20	19,533
	25	22,501
R-3	15	4,309
	20	4,979
	25	5,745
R-5	10	5,362
	15	5,171
	20	6,511
R-6	20	1,647
	25	910
	30	1,206
R-7	10	2,490
	15	2,671
	20	3,294
R-8	20	1,915
	25	1,915
	30	2,241
R-10	15	4,596
	20	3,830
R-11	15	3,447
	20	2,987
R-13	2	4,596
	4	4,673
	8	5,056

Table 3C. pH Test Results (ASTM G51)

Sample Number	Sample Depth (ft)	Sample Description	pH
SS-5p-4	10.0 – 11.5	CLAY	5.0
SS-5p-7	20.0 – 21.5	SILT, trace to some sand	5.9
SS-6p-10	25.0 – 26.5	Clayey SILT	6.1
SS-7-5	12.5 – 14.0	SILT	6.0
SS-8p-9	22.5 – 24.0	Silty CLAY, some rock fragments	6.5
SS-9-8	20.0 – 21.5	Lithic MUDSTONE	6.7
SS-10p-7	17.5 – 19.0	SILT, some rock fragments	6.8
SS-12-5	12.5 – 14.0	Sandy SILT, trace gravel and organics	6.5
SS-13p-2	5.0 – 6.5	Clayey SILT, trace sand and gravel	6.2

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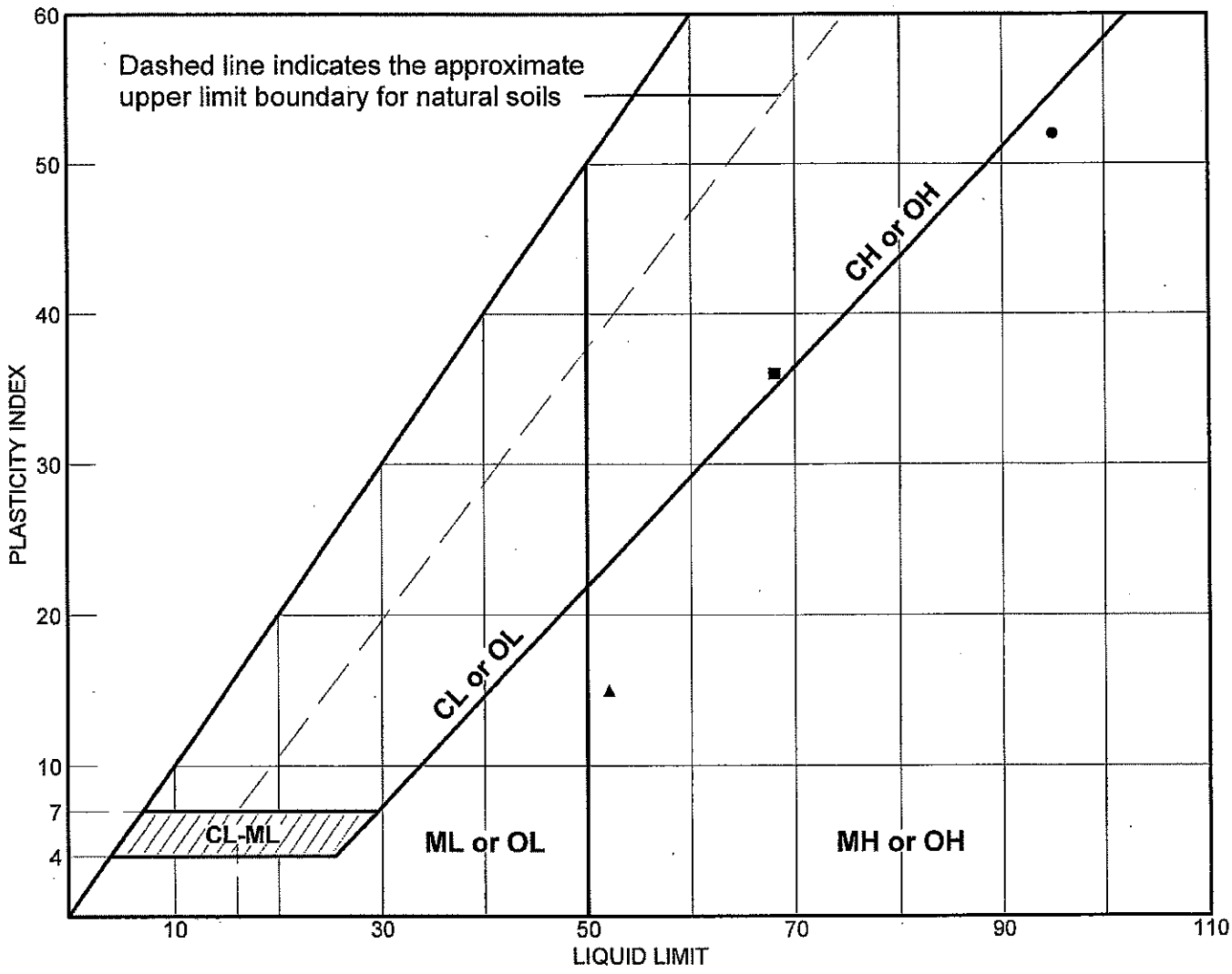

SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	4454	SS-6p-5	12.5-14.0'	52.3	43	95	52	MH
■	4454	SS-10p-2	5.0-6.5'	32.8	32	68	36	CH
▲	4454	SS-13p-2	5.0-6.5'	41.8	37	52	15	MH

ATTERBERG LIMITS REPORT - ASTM D4318

FEI Testing & Inspection, Inc.
Corvallis, OR

Client: Foundation Engineering Inc.; Project #2091089-101
Project: Jasper Trunk Sewer; Springfield, Oregon
Project No.: 2106001-514
Figure 1C