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Geotechnical Investigation Report

China Camp Creek Project
Coquille, Oregon

Prepared for:
Nehalem Marine
Attn: Mr. Leo Kuntz
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August 15, 2013
Project No. 90190.000

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1.0 INTRODUCTION

1.1 General

This report presents the results of the PBS Engineering and Environmental Inc. (PBS) geotechnical investigation for the proposed China Camp Creek Project in the Winter Lake area of Coquille, Oregon. The general site location is shown on Figure 1, Vicinity Map. The locations of our explorations in relation to existing and proposed site features are shown on Figure 2, Site Plan.

1.2 Purpose and Scope

The purpose of PBS' services was to develop geotechnical design and construction recommendations in support of the planned project. This was accomplished by performing the following scope of services.

1.2.1 Geologic Map and Literature Review

Relevant geologic maps of the site area were reviewed for information regarding geologic conditions and hazards at, or near the site. We were particularly looking for design information for the existing tide gate, berms, and maps or old photos of the site to try to determine changes over time. We also reviewed old well drilling records to determine the depth of the sediment at the site.

1.2.2 Geologic Hazard Mapping

PBS completed a review of relevant geologic hazards in the vicinity of the project site. The hazards review was performed by PBS personnel. The review consisted of the close examination of soils and surficial features including pre-development drainage patterns. We utilized Light Detection and Ranging (LIDAR) data provided by you, in our field interpretations. We included an analysis of regional structural features (such as faulting and folding) and correlated those to the underlying geology of the site. We also performed a review of other relevant geologic hazards such as landslide susceptibility, liquefaction potential, and tsunami inundation risks. The risk of river flooding due to precipitation was excluded from this hazard review.

1.2.3 Subsurface Exploration

PBS completed 11 borings across the site. The borings were advanced to depths between 31.5 and 141.5 feet below the existing ground surface (bgs). The borings were logged, the presence of groundwater documented, and representative soil samples were collected by PBS geologists. Interpreted boring logs are included in Appendix A – Field Explorations.

1.2.4 Soils Testing

All samples were returned to our laboratory and classified in general accordance with the Unified Soil Classification, Visual-Manual Procedure. Laboratory tests included natural moisture contents, sieve analyses, and Atterberg limits. Consolidation tests were performed on selected samples for compressibility characteristics. A bulk sample obtained from the proposed borrow pit was tested for classification and moisture-density relationship properties. Laboratory test results are included in Appendix B – Laboratory Testing.

1.2.5 Geotechnical Engineering Analysis

Data collected during the subsurface exploration, literature research, and laboratory testing were used to develop specific geotechnical design parameters and construction recommendations.

1.2.6 Report Preparation

This Geotechnical Engineering Report summarizes the results of our explorations and analyses, including information relating to the following:

- Boring logs
- Laboratory test results
- Earthwork and grading, cut, and fill recommendations for berms:
  - temporary and permanent slope inclinations
  - settlement estimates, mitigation, and monitoring
  - structural fill materials and preparation
  - wet and cold weather conditions considerations
- Groundwater considerations
- Shallow foundation design recommendations:
  - minimum embedment
  - allowable bearing pressure
  - estimated settlement
  - sliding coefficient
- Lateral earth pressures for embedded wall design, including:
  - active, passive, and at-rest earth pressures
  - seismic lateral force
  - sliding coefficient
- Seismic design criteria in accordance with the 2010 Oregon Structural Specialty Code (OSSC)

1.3 Project Understanding

We understand that the Beaver Slough Drainage District is working with a number of partners and funding agencies to accomplish the China Camp Creek Project (“project”), which includes the creation of some new tidal channels, deepening of existing slough channels, and other general fish and wildlife habitat improvements within the existing Winter Lake area adjacent to the Coquille River. We understand the Winter Lake area will be divided into three “units”, divided by existing or newly constructed berms, each equipped with its own tide gate to control water levels independently. The existing and proposed site features are shown on Figure 1. We further understand that Nehalem Marine Manufacturing Inc. has a contract with the Drainage District to provide tide gate structure design, fabrication, and installation as well as berm construction services, along with other possible services.

PBS has been contracted to provide geotechnical design services for this project. For the purposes of this report, PBS’s geotechnical services for the project will be considered to consist of the following:

- The replacement of the existing tide gate structures located at the southwest corner of the project area, adjacent to the Coquille River. We understand the existing two tide gates, which are located within small end berms, will be sealed and a new tide gate configuration consisting of three connected adjacent structures to be located at the junction of the two existing channels, that will eventually be connected to the proposed new waterways. The new structures will consist of concrete box culverts with wing walls and equipped with steel Muted Tidal Regulator (MTR) gates. We understand that the base of the proposed new tide gates will be located at an elevation of approximately -1 foot (NAD88) and that the top of the tide gate structure will be located at approximately 13 feet (NAD88). We understand any additional flood protection above the top of the tide gate structures will be accomplished by way of a buttressed concrete flood wall. Based on preliminary drawings provided to us by Nehalem Marine Manufacturing, Inc., including estimated structural concrete volumes, we have developed the loading criteria presented in Table 1 as follows.

Table 1: Proposed Tide Gate Structure Loading

Tide Gate	Concrete Volume (yd^3)	Approximate Weight (kips)	Footprint (ft^2)	Bearing Pressure (psf)
Structure A (Central Gates)	217	880	1,945	450
Structure B (North Gate)	94	380	759	500
Structure C (East Gates)	140	570	1,206	470

- A new north-south-trending berm will be constructed that will separate the proposed Units 1 and 2. We understand this berm will be on the order of 5 to 7.5 feet high above the existing ground surface, which we understand to be at an elevation of 2.5 to 4.5 feet (NAD88), with a proposed crest width of 12 feet and side slopes on the order of 5H:1V (horizontal to vertical). We understand that a 10-foot-wide cutoff trench is possible, depending on observed subsurface conditions. We understand this berm will be designed to accommodate a portion of the new tide gate access road.

- Existing berms will be raised to accommodate proposed higher inundation levels. We understand the existing berms are on the order of 3 to 5 feet high above the surrounding ground surface, which we understand to be at an elevation of 2.5 to 4.5 feet (NAD88), and the proposed height increase will be on the order of 2 feet. The berms to be raised include the east-west- and north-south-trending berms, which will separate the proposed Units 2 and 3, the two separate east-west-trending berms that will separate Units 1 and 2 and be connected by the new berm section, and the short segment of berm that generally parallels the railroad tracks adjacent to China Creek that provides access to State Highway 42. The proposed raised berms separating Units 1 and 2 will be designed to accommodate the new tide gate access road.

1.4 Field Exploration

A total of eleven borings were drilled to depths of up to 141.5 feet bgs by Hard Core Drilling, Inc. of Dundee, Oregon, using mud-rotary drilling techniques. The approximate exploration locations are shown on Figure 2. Field exploration methods and interpreted boring logs are presented in Appendix A.

1.5 Laboratory Testing

Soil samples obtained during our explorations were returned to the laboratory to assist in soil classification and to evaluate their general physical properties and engineering characteristics. Laboratory testing included natural moisture content and two Atterberg limits. Some of the results of laboratory testing are included on the boring logs. Consolidation tests were performed on selected samples to evaluate compressibility characteristics. A bulk sample obtained from the proposed borrow pit was tested for classification and moisture-density relationship properties. Laboratory testing methods and full test results are presented in Appendix B – Laboratory Testing.

2.0 SITE CONDITIONS

2.1 Surface Description

The China Camp Creek Project site is located within the Winter Lake area of Coos County, Oregon. Winter Lake is an area of marginal coast land located north of the Coquille River, just downstream from Coquille, Oregon. The area is bordered by the Beaver Slough to the northwest, Oregon Route 42 to the northeast, and the Coquille River to the south and southwest. The majority of the site is located just above (approximately 2.5 to 4.5 feet on average) the mean sea level (NAD88) and is, therefore, prone to tidal flooding. A series of existing berms, lineal ditches and tidal channels, and tide gates currently control and limits tidal flooding in the area, allowing the site to be used for agriculture and grazing for part of the year.

2.2 Geologic Setting

According to published geologic mapping of the site region (Beaulieu & Hughes, 1975), the site is predominantly underlain by a marsh and peat unit (Holocene). The marsh and peat unit consists of normally consolidated deposits of organic silt, clay, and sand. The mapping indicates that the marsh and peat unit is generally associated with, and overlies the alluvium consisting of unconsolidated or normally consolidated sand, silt, and clay. The maps indicate sedimentary sandstone and siltstone bedrock of Eocene-age Coaledo Formation that underlie the alluvium at depths greater than 100 feet, and was not encountered at 141.5 feet bgs during our investigation.

2.3 Geologic Hazards

According to published geologic mapping of the site region (Beaulieu & Hughes, 1975), the site is not at risk of slope instability or other mass movement.

The project site is subject to seismic events stemming from three possible sources: the Cascadia Subduction Zone (CSZ) at the interface between the Juan de Fuca plate and the North American plate, intraslab faults within the Juan de Fuca plate, and crustal faults in the North American plate. Maximum magnitude for a CSZ event is expected to be in the range of Moment Magnitude (MW) 8.5 to 9.0. Known and suspected crustal faults in the region have been characterized for the United States Geological Survey (USGS) and the Oregon Department of Geology.

The closest Quaternary local geologic structure to the site is the South Slough syncline which is located approximately 2.5 miles to the northwest of the proposed project site. The South Slough syncline is a north-striking syncline running north to south. The effective length of the structure is approximately 11 miles and the slip ranges from 0.2 to 1.0 mm/year. The most recent prehistoric deformation took place in the latest Quaternary (Personius, 2002).

Based on our knowledge of the existing site subsurface conditions including the results of our laboratory testing, the site does not have a high potential for liquefaction induced settlement.

Recent tsunami inundation mapping of the Leneve and Coquille regions along the Coquille River indicate that the entire site is located in a region susceptible to inundation during a Cascadia Subduction Zone event, which is expected to result in wave heights on the order of 10 to 18 feet in elevation (NAD88), depending on the magnitude of the event (Priest et al., 2012).

2.4 Subsurface

2.4.1 Discussion

Subsurface conditions at the site were explored by drilling eleven borings. Logs summarizing the subsurface conditions encountered in the borings are presented in Appendix A. The soil conditions observed during the subsurface investigation are summarized as follows.

2.4.2 Soils

Subsurface conditions consist of fill, overlying the marsh and peat unit, which in turn overlies alluvium. We have summarized the soil and rock units as follows:

FILL	Encountered at the surface in nine of the eleven borings. Consists of very soft to medium stiff silt with trace to some silt, sand, and organics. Thickness the fill ranged between 2 and 8 feet thick.
MARSH AND PEAT	Encountered below the fill in seven of the eleven borings. Consists of very soft, organic silt to organic clay. These materials were observed between the depths of 2 to 15 feet bgs.
ALLUVIUM	Encountered in all the borings, to the termination depths in alluvium at 31.5 to 141.5 feet bgs. The alluvium consisted of very soft to medium stiff silty clay to clayey silt with medium to high plasticity and trace to some fine sand and organics.

Interpreted profiles of the subsurface conditions encountered along the north-south berm separating units two and three, the proposed new north-south berm to separate units one and two, and the tide gate region that are included on Figure 3, Profile A-A’, Figure 4, Profiles B-B’ and C’-C’.

2.4.3 Groundwater

Groundwater was not observed during the explorations due to the mud rotary drilling techniques used. It should be noted that the laboratory testing results show saturated soil conditions at depths of 2.5 to 7.5 feet bgs during our investigation. We anticipate that the groundwater level will fluctuate with the seasons, tidal conditions, and the water level in the adjacent Coquille River and the existing slough channels. We understand that much of the site area is flooded throughout the winter months due to heavy precipitation, mountain runoff, and the rise in the adjacent Coquille River.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Geotechnical Design Considerations

PBS explored the subsurface conditions with eleven borings at various locations across the site, as shown in Figure 2. Soils encountered included fill at the locations of the existing berms and tide gates, overlying native soils which consist of a thin layer of very soft organic silt and clay, which overlies alluvium consisting of very soft to medium silty clay to clayey silt with trace to some fine sand and organics. The interbedded silt, clay and silty sand of the alluvium was encountered to the depth of termination (up to 141.5 feet bgs).

Regarding the construction of the new and raised berms, a complete grading plan for the project had not been completed when this report was prepared. Our recommendations are based on a conceptual understanding of the proposed new berm and raised berms, as shown on Figure 5. We understand the final berm heights will be controlled by operational requirements, not yet determined. Subsequently, we cannot yet fully evaluate the impacts of site grading on the stability of the existing slopes or settlement of the underlying soils. Our discussion below provides general recommendations for slopes, settlement mitigation, and other geotechnical concerns for berm design and construction. When it is complete, the grading plan should be provided to us for review and evaluation prior to finalizing the construction plans.

3.2 Tide Gate Foundations

We understand that the proposed three new tide gate structures will be connected by way of a common downstream wall, and will be constructed within an excavation behind the existing embankment at the Coquille River between the locations of the existing tide gates structure. We anticipate cuts of approximately 5 to 10 feet into the existing embankment and below the existing ground surface will be required prior to construction of the new tide gate structure.

We understand that the proposed current plan for the proposed new tide gate foundations is for them to be supported on shallow mat foundations. We currently estimate that the installation of these mat foundations will result in settlements on the order of 4 or 5 inches during and after construction. If these settlements are not deemed tolerable to the overall project design, we have provided deep foundation recommendations for your consideration.

We estimate that regardless of the foundation system employed, construction for the proposed tide gate foundations will extend below the seasonal groundwater table. As a result, dewatering of the excavation will be necessary during construction. Our recommendations for construction dewatering are included in the Construction Recommendations section of this report.

3.2.1 Shallow Mat Foundations

The following recommendations have been provided for the design and construction of shallow mat foundations for the support of the proposed new tide gate structures.

3.2.1.1 Footing Preparation

PBS recommends that all footing excavations be trimmed neat and footing subgrades carefully prepared. PBS should confirm suitable bearing conditions and evaluate all footing subgrades. Observations should also confirm that loose or soft material, organics, unsuitable fill, and old topsoil zones have been removed from excavations for footings and concrete slabs on grade. Localized deepening of footing excavations may be required to penetrate any soft, wet, or deleterious materials.

In our opinion, the existing subsurface soils are not suitable for direct support of the proposed tide gate structures due to consolidation and bearing capacity concerns. We recommend that the proposed tide gate structures be supported on a 3-foot thick granular stabilization fill pad constructed by removing the existing native soils down to that depth. The stabilization fill pad should extend outward beyond the footings at least 3 feet in all directions. Recommendations for granular stabilization fill are included in the Construction Recommendations Section.

3.2.1.2 Footing Widths / Bearing Pressure

The proposed mat foundation should bear on the above-mentioned stabilization fill pad and should be sized using a maximum allowable bearing pressure of 1,500 psf. The recommended allowable bearing pressure applies to the total of dead plus long-term-live loads. Allowable bearing pressures may be increased by one-half (½) for seismic and wind loads.

3.2.1.3 Foundation Static Settlement

Footings will settle in response to structural loads, the change in effective stress due to the removal of some of the existing overburden soils and the replacement of the existing subgrade soils with the above-mentioned stabilization fill pad. Based on these combined effects and our evaluation of the subsurface conditions, we currently estimate static settlement on the order of 4 to 5 inches.

Anticipated settlements can be reduced somewhat by preloading the site for a period of time prior to construction of the new structure. This would involve placing fill materials temporarily over the area where the structure will be constructed and allowing settlement to take place. The preload fill should weigh at least as much as the structure to be constructed and extend at least 15 feet beyond the limits of it. The settlement should be monitored to confirm the effectiveness of the preload fill. If preloading is chosen for mitigation of static settlement of the tide gate foundations, PBS should be contacted to provide a preloading program, including loading recommendations, time-to-settlement estimates, and detailed pad requirements.

3.2.1.4 Lateral Resistance

Lateral loads can be resisted by passive earth pressure on the sides of footings and embedded walls and by friction at the base of the footings. A passive earth pressure of 125 pounds per cubic foot (pcf) may be used for footings confined by native soils and new backfills. The allowable passive pressure has been reduced by half to account for the large amount of deformation required to mobilize full passive resistance. For footings in contact with stabilization fill pad, use a coefficient of friction equal to 0.35 when calculating resistance to sliding. These values do not include a factor of safety.

3.2.1.5 Seepage

The stabilization fill pad below the proposed mat foundations will create a seepage pathway below the proposed tide gate structures. In order to mitigate this seepage, we recommend the installation of a sheet pile wall system below the downstream footing edge (toe) of the proposed tide gates. The sheet pile wall should be watertight to prevent groundwater flow, and should be continuously connected to the footing through all three tide gate structures. The wall should extend at least 20 feet below the bottom of the stabilization fill pad, down into the native silty clay soils.

Installation methods for a sheet pile wall are typically selected by the contractor. PBS should be retained to review and comment on the contractor's proposed method and equipment for installation, and observe the installation.

3.2.2 Pile Foundation Design Recommendations

Piles are a standard method of foundation support in soft cohesive soils. And they would provide a suitable alternative support system if the predicted mat foundation settlement cannot be tolerated by the proposed structure.

The pile capacities would primarily be derived by skin friction, with the subsurface soils being too soft to provide any significant end bearing. A significant structural foundation system involving grade beams or grouped pile caps would be needed to span between the piles. The parameters provided in Table 2 were developed to analyze the vertical- and lateral-load capacity of the deep foundation system.

Table 2: Soil Profile and Soil Parameters

Depth feet (bgs)		Soil	N-values $(N_1)_{60}$	Effective Unit Weight (pcf)	Friction Angle ϕ	Undrained Cohesion c (psf)	p-y Modulus (pci)
0	15	Very Soft Clay	0	33	28	500	75
15	40	Very Soft Silty Clay	0	38	28	500	75
40	55	Very Soft Silty Clay	0	38	28	750	75
55	70	Medium Stiff Silty Clay	6	40	28	750	75
>55		Very Soft Silt	0	40	28	500	75

PBS analyzed pipe piles. As mentioned above, the piles would develop their capacity primarily from skin friction in the underlying soft alluvium with limited contribution from end bearing. Pipe piles shall have a closed end. Table 3 presents the allowable capacity for each pile analyzed. This analysis presents a range of pipe pile capacities depending on pile diameter and depth of embedment below the bottom of the proposed tide gate structures.

Table 3: Allowable Vertical Pile Capacities

	Allowable Vertical Pile Capacity (kips)		
Embedment Depth (ft)	**Pile Diameter (in)**		
	12	14	16
20	10	12	14
30	15	18	21
40	22	25	29
50	30	35	40

[1] Factor of Safety of 3.0 used for vertical capacities (Factor of Safety can be reduced if load test is completed).

Uplift capacity is also derived from skin friction in the soft alluvium, and for the purposes of design can be considered equal to the axial capacity. The loads given above are for individual piles; group efficiency should be considered when the pile spacing in the direction of loading is less than 5-pile diameters on center. The axial and uplift capacities for each pile in the group should be reduced in accordance with the values provided in the Axial Pile Group Efficiency table below (Table 4). We recommend the minimum spacing be 3 pile diameters. Calculated capacities do not consider the ultimate structural capacity of the pile; therefore, we recommend that a structural engineer check the allowable stress of the piles.

Table 4: Axial Pile Group Efficiency

Pile Spacing (pile diameters)	Group Efficiency Factor
3	0.75
4	0.9
5	1.0

The allowable capacities were computed for static conditions and include a factor of safety of 3.0. If the piles are analyzed using a PDA or if a load test is used, the factor of safety can be significantly reduced.

The capacities presented apply to the total of dead and live loads exclusive of wind and seismic loading. The allowable capacities shown in the following table can be increased by a factor of 1.5 when considering seismic and wind loads.

Supporting the tide gates on piles will allow for the structure to bear on the lower, less compressible soils, and therefore we anticipate settlement of the piles will be generally less than an inch. Differential settlement should not exceed 50 percent of the total vertical settlement.

Lateral-load analysis has not yet been completed. If piles are considered further for use to support the tide gates we will provide recommendations for lateral pile load capacities using the computer program LPILE® Plus (Version 5.0) for the soil profile presented in Table 2 above.

Table 5: Lateral Group Action

Pile Spacing (pile diameters)	Load-Reduction Factor
3	0.25
4	0.40
6	0.70
8	1.0

Please note that driving piles causes vibration. Careful consideration should be given to the nearby structures and wildlife and fish before any pile driving is done at the site. If vibration is deemed to be of greater concern at the site, then consideration should be given to other installation techniques such as vibratory hammers, or other deep foundation systems which do not result in such high vibrations during construction.

Driving criteria, including hammer size and driving cushion, is typically selected by the pile-driving contractor. Driving criteria should be established using the Wave Equation or other approved method prior to pile installation. PBS should be retained to review the contractor’s proposed method and equipment for pile installation.

The piles should be tied together using grade beams or group pile caps. Additional lateral-load carrying capacity can be obtained from passive resistance in front of the grade beams or pile caps, and other buried foundation elements. Assuming a maximum translation of one (1) inch, the allowable passive resistance on the face of buried foundation elements may be computed using an equivalent fluid density of 125 pounds per cubic foot (pcf) for foundation elements cast neat against the existing soil or backfilled with structural fill. Friction at the base of the pile caps and grade beams should not be included in these calculations.

3.2.2.1 Seepage

Installation of the piles will require the construction of a granular working pad, which will be incorporated in the foundation system after construction. This granular working mat has the potential to conduct seepage below the proposed tide gate foundations. In order to mitigate this seepage, we recommend the installation of a sheet pile wall system below the downstream footing of the proposed tide gates. The sheet pile wall should be watertight to prevent groundwater flow, and should be continuously connected to the footing, through all three tide gate structures. The wall should extend at least 20 feet below the bottom of the stabilization fill pad, down into the native silty clay soils.

Installation methods for a sheet pile wall are typically selected by the contractor. PBS should be retained to review and comment on the contractor's proposed method and equipment for installation, and observe the installation.

3.3 New Berm Embankments

Proposed preliminary embankment sections for the new berm are shown on Figure 5. In summary, we understand that the proposed new berm crest will be located at an elevation of 5 to 7 feet (NAD88) to accommodate the proposed maximum water surface level of 3 to 5 feet (NAD88) with a 2-foot freeboard. The existing ground level at the location of the proposed new berm embankment varies in elevation from 2.5 to 4.5 feet (NAD88), indicating the new berm will consist of approximately 0.5 to 4.5 feet of fill above the existing ground surface. We understand the proposed embankment fill will consist of clayey silt material imported from a local borrow pit. The proposed sections are based on design criteria provided by you, our understanding of the existing berm construction, and on considerations of settlement and stability, which are discussed below. We understand that the proposed design criteria are preliminary in nature and as a result, our recommendations may need to be revised to reflect any significant changes.

Sustained storm winds blowing across the inundated expanse of Winter Lake will result in waves being generated. Our current estimate suggests that waves as high as 2.5 feet in height may result. To avoid wave damage to the berms, we recommend maintain a minimum freeboard of 2.5 feet.

3.3.1 Slope Stability

The following minimum slope stability criteria (Table 2) for similar berm embankments have been recommended by the U.S. Army Corps of Engineers (USACE, 2000). For a given embankment to be considered stable under a given condition, a slope stability analysis would have to result in a factor of safety greater than the listed minimum.

Table 6: Slope Stability (USACE, 2000)

Condition	Minimum Factor of Safety
End of Construction	1.3
Rapid Drawdown	1.0
Long-Term Full Flood Stage	1.4
Seismic Stability	1.0

Based on the design criteria provided by you, the proposed geometry for the upstream and downstream embankment slopes is 5H:1V, or flatter. If the proposed new berms are constructed in accordance with these criteria, the berms should have calculated factors of safety that are greater than the criteria presented in Table 6.

Our seismic stability analysis for earthquake loading conditions was based upon a pseudo-static computer analysis code. However, in the event of a major seismic event on the Cascadia Subduction Zone, a resulting tsunami would most likely overwhelm the site, overtopping the berms and severely damaging them. The berms provide flood protection for agricultural land and fish habitat, which do not include human habitation. If such a major earthquake event occurs, some rehabilitation earthwork will likely be required to repair the berms.

We recommend that the berms should be designed to have at least 2 feet of freeboard above the normal high water level, and include an appropriate camber as described below.

3.3.2 Seepage

Seepage failures for berms typically occur as a result of high hydraulic exit gradients that initiate heave and/or piping of the soil particles. To prevent these high exit gradients, the foundation conditions and berm cross section must allow for enough head loss as the water seeps through or under the berm to reduce the hydraulic gradients to acceptable levels where they exit on the downstream side of the berm. Our borings indicated that the foundation soils predominantly consisted of moderate to high plasticity silty clay to clayey silt with trace to some sand and organics, which are relatively low permeability materials. Therefore, high downstream exit gradients for an under-seepage is unlikely, as long as the subgrade for the berm is prepared adequately as described under Construction Recommendations (Section 4.0).

We recommend that a “cutoff” trench, as shown in Figure 5, be excavated under the proposed new berm embankment. The purpose of this trench would be to intercept near-surface voids, such as animal burrows and root mats. The trench should be at least 10 feet wide and 2 to 3 feet deep, as shown on Figure 5.

The cutoff trench should be backfilled with inorganic, low permeability soil with some plasticity, such as the clayey silt borrow material. The trench backfill should be 2 to 4 percent wet of the optimum water content at the time of the placement. The backfill should be placed in lifts not exceeding 6 inches (loose) and each lift should be compacted to 92 percent of the maximum dry density, based on ASTM D698

The trench excavation spoils will not be suitable for use as backfill, in our opinion, due to the high natural water content, high compressibility, and the presence of organic matter in the near-surface native soil.

Based on evaluation of the proposed berm cross-section, our current opinion is that the low water head behind the berm (maximum 5 feet) and the high plasticity of the proposed berm and cutoff trench fill and foundation materials indicate that the likelihood for high exit gradients that would lead to piping failures is low.

Penetrations through the berms, aside from the above-mentioned tide gates, are especially vulnerable to piping failures and should be avoided. If included, these features will require special construction attention and performance monitoring.

3.3.3 Settlement

The foundations soils beneath the proposed new berm will undergo consolidation settlement due to the load imposed from the weight of the new embankment fill for the berm. Based on the high plasticity characteristics of the foundation soils and the anticipated loading conditions from the weight of the new berm embankment fill, we have developed the estimates of settlement provided in Table 7. While the site soils are generally considered to be normally consolidated, based on our past experience with similar soils, we anticipate that the settlement estimates of normally consolidated soils are overly conservative. Our settlement estimates have taken this into account.

Table 7: Settlement Estimates for New Berm Embankment

Berm Crest Height Above Existing Ground Surface (feet)	Estimated Settlement (ft)
3.0	0.0 – 0.4
4.0	0.4 – 0.6
5.0	0.7 – 0.9
6.0	0.9 – 1.2

Some of the primary consolidation settlement will likely occur during construction as the fill material is placed; however, consolidation settlement is expected to continue for some time after construction. After consolidation is complete, we anticipate that settlements resulting from compression of the soil structure will continue as a function of time. This time-related settlement is referred to as secondary compression. We have estimated that over a 50-year design life, the underlying foundation soils could settle an additional 0.5 to 1 foot after the consolidation settlement is complete and therefore, some occasional maintenance of the crest of the berm will likely be necessary.

The estimated resulting settlement estimates presented in Table 3 are based on data obtained from the consolidation tests described in Appendix B, Figure B2, and on information obtained from the exploratory borings. Due to probable variations in subsurface conditions, these estimates must be considered approximate.

We recommend that settlement monitoring be performed after fill placement has been completed so that estimates can be made regarding the total anticipated remaining settlement and the time for completion of the majority of settlement. Specific recommendations for settlement monitoring are provided under Construction Recommendations below. Once the berm is completed, the settlement monitoring program described under Construction Recommendations (Section 4.0) should be initiated.

3.4 Raising Existing Berm Embankments

We understand that raising of some of the existing berms to bring them in line with the crest elevation of the new berm is proposed. To this measure, we estimate embankment fills on the crest of the existing berms on the order of 2 feet may be necessary. We understand the proposed embankment fill will consist of the same silty clay imported from a local borrow pit for the new embankment berm. We further understand that the proposed design criteria are preliminary in nature and as a result our recommendations may need to be revised in the future to reflect any significant changes.

3.4.1 Slope Stability

Based on the design criteria provided by you, the proposed geometry for the improved existing berm upstream and downstream embankment slopes is 5H:1V, or flatter. If the existing raised berms and new berm are constructed in accordance with these criteria, our opinion is that the berms will have calculated factors of safety that are greater than the criteria presented in Table 6.

Due to the presence of the existing drainage channels adjacent to many of the berm sections which are being raised, we recommend that the raising of the existing berms be done to the opposite side of these existing channels. This will allow for the construction of flatter slopes and provide for additional protection to the “wet” side of the existing structures.

Our seismic stability analysis for earthquake loading conditions was based upon a pseudo-static computer analysis code. However, in the event of a major seismic event on the Cascadia Subduction Zone, a resulting tsunami would most likely overwhelm the site, overtopping the berms and severely damaging them. The berms provide flood protection for agricultural land and fish habitat, which do not include human habitation. If such a major earthquake event occurs, some rehabilitation earthwork will likely be required to repair the berms.

We recommend that the raised berms should be designed to have at least 2 feet of freeboard above the normal high water level and include an appropriate camber as described below.

3.4.2 Seepage

Considering the low water head behind the berm (maximum 5 feet) and the plasticity of the proposed berm fill and foundation materials, our current opinion is that the likelihood for high exit gradients that would lead to piping failures is low. Our current understanding is that minor groundwater seepage is being intercepted by the adjacent drainage channels. We do not foresee a significant or hazardous increase in seepage as a result of the above-mentioned modifications provided the berms are well maintained and periodically monitored.

3.4.3 Settlement

The foundation soils beneath the proposed raised berm embankments will also undergo consolidation settlement due to the increased load imposed from the weight of the new embankment fill for the berm. Based on the high plasticity characteristics of the foundation soils and the anticipated loading conditions from the weight of the new berm embankment fill, we estimate that the berms may settle as much as 0.2 to 0.4 feet due to consolidation. While the site soils are generally considered to be normally consolidated, based on our past experience with similar soils, we anticipate that the settlement estimates of normally consolidated soils are overly conservative. Our settlement estimates have taken this into account.

After primary consolidation is complete, we anticipate that settlements resulting from secondary compression of the soil structure will continue as a function of time. This time-related settlement is referred to as secondary compression. We have estimated that over a 50 year design life, the underlying foundation soils could settle up to an additional 0.25 to 0.5 feet.

We recommend that settlement monitoring be performed after fill placement has been completed so that estimates can be made regarding the total anticipated remaining settlement and the time for completion of the majority of settlement. Specific recommendations for settlement monitoring are provided under Earthwork Recommendations below. Once the berm is completed, the settlement monitoring should be initiated.

3.5 Settlement Mitigation

We understand that you currently anticipate incorporating the anticipated settlements into the new and raised berm design by adding an over-build, or camber, to the design section. Alternatively, the predicted settlement could be mitigated through pre-loading of the subsurface soils prior to construction of the new berm. The preload period would probably require one construction season. As described above, we recommend that the berms should be designed to have at least 2.5 feet of freeboard above the normal high water level after settlement is complete.

3.5.1 Over-build (Camber)

Overbuilding of berms to account for predicted settlements is common. Based on settlement analyses which take into account the additional loading from the increased height of the embankment, we have developed the following recommendations for over-build of both the proposed new berm and the raised existing berms.

Table 8: Recommended Overbuild Dimensions

Berm Crest Height Above Existing Ground Surface (ft) or proposed raised height (ft)	Recommended Overbuild (ft)
Proposed New Berm	
3.0	0.3
4.0	0.6
5.0	1.0
6.0	1.3
Raised Existing Berms	
2.0	0.2

The settlement estimates are based on data obtained from the consolidation tests described in Appendix B, and on information obtained from the exploratory borings. Due to probable variations in subsurface conditions, these estimates must be considered approximate. As mentioned above, once the berms are completed, the settlement monitoring in the Construction Recommendations section below should be initiated.

3.6 Seismic Design Criteria

The current seismic design criteria for this project are based on the 2010 OSSC, Section 1613. The seismic design criteria, in accordance with the 2010 OSSC, are summarized in Table 9.

Table 9: 2010 OSSC Seismic Design Parameters

	Short Period	**1 Second**
Maximum Credible Earthquake Spectral Acceleration	S_s = 1.50 g	S_1 = 0.72 g
Site Class	E	
Site Coefficient	F_a = 0.90	F_v = 2.40
Adjusted Spectral Acceleration	S_{MS} = 1.35 g	S_{M1} = 1.72 g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.90 g	S_{D1} = 1.15 g
Design Spectral Peak Ground Acceleration	**0.36 g**	

3.7 Liquefaction

Liquefaction analysis for the project site was conducted based on the information obtained from our borings and using the procedure suggested by NCEER (Youd, 2001). The design earthquake is a moment magnitude 9.0 with peak ground acceleration (PGA) of 0.36 g. Our analysis indicates a relatively low liquefaction potential in the native materials. This is primarily due to the fine-grained and plastic nature of the subsurface soils. Therefore, our current opinion is that liquefaction is not considered a significant hazard at this site.

4.0 CONSTRUCTION RECOMMENDATIONS

4.1 Site Preparation

The site should be stripped of any organic material before any improvements takes place. We recommend that the grass mat, which was approximately 3 to 6 inches throughout the site, should be stripped before new structural fill is placed. Trees and shrubs should be removed from all fill areas. In addition, root balls should be grubbed out to the depth of the roots which could exceed 3 feet bgs. Depending on the methods used to remove the root balls, considerable disturbance and loosening of the subgrade could occur during site grubbing. We recommend soil disturbed during grubbing operations be removed to expose firm, undisturbed subgrade. The resulting excavations should be backfilled with compacted borrow material.

Demolition should include removal of any existing structures within the footprint of the new structures, including any remnant foundation elements. The voids resulting from removal existing structures should be backfilled with compacted structural fill. The base of these excavations should be excavated to relatively firm subgrade before filling, with sides sloped at a minimum of 1H:1V to allow for uniform compaction.

Materials generated during stripping and demolition should be transported off-site or stockpiled in areas designated by the owner.

4.1.1 Subgrade Verification

Following stripping/excavation and prior to placing fill, pavement, or building improvements, the exposed subgrade should be evaluated for suitability. The subgrade should be evaluated through the use of a probe or other standard of practice by an experienced geotechnical engineer. We recommend that PBS be retained to perform these verifications. Soft or loose zones identified during the field evaluation should be excavated and replaced with structural fill.

4.1.2 Subgrade Protection

Once subgrades have been stripped and verified, the clayey soils should be covered within 4 hours of exposure by a 6-inch lift of compacted borrow material.

4.1.3 Wet-Weather/Wet-Soil Conditions

Due to the presence of clay soils at the site, construction equipment may have difficulty operating on the near-surface soils when the moisture content of the surface soil is more than a few percentage points above optimum. Soils that have been disturbed during site-preparation activities, or soft or loose zones identified during probing, should be removed and replaced with compacted structural fill.

Track-mounted excavating equipment may be required during wet weather. The thickness of the haul roads and staging areas will depend on the amount and type of construction traffic. The material used for haul roads should be stabilization material described below. A 12- to 18-inch-thick mat of stabilization material should be sufficient for light staging areas. The stabilization material for haul roads and areas with repeated heavy construction traffic typically needs to be increased to between 18 to 24 inches. The actual thickness of haul roads and staging areas should be based on the contractor’s approach to site work, the amount and type of construction traffic, and is the contractor’s responsibility. The stabilization material should be placed in one lift over the prepared, undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. Additionally, a geotextile fabric should be placed as a barrier between the subgrade and stabilization material. The geotextile should meet specifications ODOT SS Section 2320.10 and SS 02320.20, Table 02320-1 for soil separation. The geotextile should be installed in conformance with ODOT SS 0350.00 – Geosynthetic Installation.

4.2 Excavation

Near-surface soils at the site consist of silt and clay that can be excavated with conventional earthwork equipment. Sloughing and caving should be anticipated.

Trench cuts should stand relatively vertical to a depth of approximately 4 feet bgs, provided no groundwater seepage is present in the trench walls. Open excavation techniques may be used in silt, sand, and clay, provided the excavation is configured in accordance with the Occupational Safety and Health Administration (OSHA) requirements, groundwater seepage is not present, and with the understanding that some sloughing may occur. The trenches should be flattened if sloughing occurs or seepage is present. Subsequently, the use of approved temporary shoring is recommended for cuts that extend below groundwater seepage or if vertical walls are desired for cuts deeper than 4 feet bgs. However, our current opinion is that groundwater control methods would also be required for excavations penetrating below seasonal groundwater levels. If dewatering is used, we recommend that the type and design of the dewatering system be the responsibility of the contractor, who is in the best position to choose systems that fit their overall plan of operation.

All excavations should be made in accordance with applicable OSHA and State regulations. The contractor is responsible for adherence to the OSHA requirements.

4.2.1 Construction Dewatering

Open excavation techniques may be used for excavations for construction of the tide gate structure. The side walls of the excavation should be appropriately sloped or shored to provide workers' protection. Because of the location and the presence of the Coquille River and adjacent drainage channels, the excavation most likely will require construction inside of a cofferdam. In addition, a dewatering system most likely will be required as well to dewater the cofferdam and control groundwater. We recommend that the type and design of the cofferdam and dewatering systems be the responsibility of the contractor, who is in the best position to choose systems that fit their overall plan of operation. Because of the importance of the cofferdam and dewatering system on the completion of the project, we further recommend that a separate bid item be included for the preparation of the cofferdam and dewatering system design by an experienced engineer licensed to practice in the State of Oregon. We further recommend that the design be submitted for comment by the project design team prior to payment for that item.

4.3 Embankment Fill

The final embankment crest heights for the new and raised berms are currently unknown, though our current understanding is there could be fills on the order of 5 feet. Given the existing site topography, cuts will likely be less than about 5 feet in height. Embankment fill should be placed over subgrades which have been prepared in conformance with the Site Preparation section of this report.

Fill placed on slope steeper than 5H:1V must be keyed/benched into the existing slopes and installed in horizontal lifts. Vertical steps between benches should be approximately two feet. Embankment fill should only be installed on subgrades that have been prepared in accordance with the preceding recommendations.

The soils encountered in our explorations are not recommended for re-use as embankment fill, due to the presence of organic material, and high moisture contents. In our opinion, significant drying of soils would be required to achieve optimum moisture content for compaction. The silt and clay fraction of these soils is moisture sensitive, and during wet weather, may become unworkable because of excess moisture content. In order to reduce moisture content some aerating and drying of native or imported silty soils may be required. We recommend that embankment fills be placed in horizontal lifts not exceeding about 8 inches in loose thickness and be compacted to at least 92 percent of the maximum dry density as determined by the standard Proctor test method (ASTM D 698).

With respect to the current plans, a brief characterization of some of the acceptable materials and our recommendations for their use as structural fill is provided below.

4.3.1 Native Soil

Near-surface native soils at the site consist predominantly of silt and clay. Due to the difficulty required to dry silt and clay to near optimum moisture content, re-use of native silt and clay as structural fill is not likely feasible except during dry summer months. Even then, it may require several days of constant mixing in order to achieve the desired moisture content.

4.3.2 Borrow Material

We understand that the proposed borrow source for the berm embankment fill is located north of the site. We collected a bulk sample within this area in order to evaluate the properties of the soil in the borrow area. Table 6 below summarizes the results of a series of laboratory test results that were performed on the soil in the borrow area.

Table 10: Properties of the Proposed Embankment Borrow Material

Soil Property	Result/Description
Material Description	Clayey SILT (MH)
Geologic Description	Weathered Siltstone
Natural Moisture Content (%)	21.8
Optimum Moisture Content (%)	19
Maximum Dry Density (pcf)	97.5
Percentage Passing #200 Sieve (%)	82
Liquid Limit (%)	60
Plasticity Index (%)	26

In our opinion, the proposed borrow material would be suitable for use as fill for the proposed berm. Topsoil and other near surface soils containing excessive organics which overlie the borrow source area should be stripped off and disposed. We recommend that PBS observe excavation of the borrow area as it is developed to monitor for the borrow source for uniformity of characteristics. The borrow material is derived from decomposed siltstone bedrock, and may vary significantly with depth. Additional lab testing and other verification may be necessary.

The measured properties presented in Table 1 suggest that the natural moisture content is only slightly (approximately 3 percent) higher than the optimum moisture content for compaction. As a result, the soil material might not require significant moisture conditioning (drying) before it can be placed and compacted. However, the sample tested was obtained from an exposed face, and the moisture content could increase significantly deeper into the borrow source. The moisture content of the borrow soil should be verified during excavations to assure the moisture content remains near the appropriate level for placement and compaction. The high plasticity of the soil indicates that it will readily retain moisture, making drying (or reduction in moisture content) difficult to achieve.

If necessitated due to high moisture contents, the contractor will need to build a staging area where the excavated material can be moisture conditioned prior to placing the material as fill within the berm. Alternatively, the soil can be placed in a horizontal lift on the berm and moisture conditioned in place. However, we anticipate that this method of conditioning would probably adversely impact the efficiency with which the fill could be placed. In addition, especially for the first couple lifts of fill placement, the multiple passes of disking equipment required to moisture condition the fill in place may result in disturbance of the foundation soils beneath the fill.

Methods of moisture conditioning include continuous disking (or plowing) or use of admixtures such as lime treatment. If required, we recommend that the contractor be permitted to select the form of moisture conditioning that they would like to use. However, the specifications should require that the contractor submit a plan for moisture conditioning and that they gain approval on any soil admixture designs that they intend to use.

4.3.3 Granular Stabilization Fill

The granular stabilization fill pad shall meet the specifications provided in ODOT SS 00330.14 – Selected Granular Backfill.

Selected granular backfill should be placed in lifts with a maximum uncompacted thickness of 12 to 18 inches and be compacted to not less than 92 percent of the maximum dry density, as determined by ASTM D 698. A Subgrade Geotextile in accordance with Table 02320-1 (separation) ODOT SS should be placed beneath stabilization fill pad.

4.4 Erosion Protection

The slopes of berms may be impacted by surface erosion from tidal and wave action, surface runoff, and wind action. The need for erosion protection for the berm during, and after construction, depending on several factors, such as:

- The length of time that water will be acting against the berm.
- The velocity of water flowing adjacent to the berm.
- The susceptibility of the berm fill to erosion.
- The presence of shielding of currents against the berm (i.e. timber stands).
- The presence of structures on the riverside of the berm that constrict flow and cause turbulence.
- The presence of abrupt transitions or short-radius bends in the berm.
- The slope of the upstream side of the berm.

Methods of protection vary from seeding the slope with grass, placement of a surface gravel layer, placement of geosynthetic reinforcement layers, or placement of a riprap revetment. We recommend that the need for erosion protection be considered as part of the design of the berm. If desired, we can provide assistance in erosion protection design.

4.5 Performance Monitoring

As described above, we recommend that the rate of settlement be monitored once the fill placement is completed. The elevation of the crest of the berm should be monitored approximately every 500 feet along the berm. It is important that the first set of settlement readings be taken immediately after the fill section is complete at each monitoring location. The readings should be taken daily for at least two weeks followed by weekly readings until the consolidation settlement is substantially complete. We also recommend that measurements be taken on an annual basis during the design life of the berm to make sure that the crest elevation does not settle beneath the design crest elevation as a result of secondary compression. The elevation of the crest should be plotted against time and reviewed by a qualified geotechnical engineer. In order to maintain at least 2-foot of freeboard above the maximum water level, it may be necessary to add additional fill in the future as the berm continues to settle.

In addition to the settlement monitoring described above, we also recommend that regular periodic inspections of the berms be performed to verify their continuing performance. These observations should include monitoring for animal burrows, potential erosion or seepage conditions, proper control of vegetation growth, and damage from livestock passage, as well as other inspections typical for similar berm embankments.

In the event of a major seismic event, a complete evaluation of the site should be performed, including the berm embankment slopes, monitoring for settlement along the crest of the berms, and an evaluation of any disturbance to the tide gates and surrounding structures and earthwork.

5.0 ADDITIONAL SERVICES AND CONSTRUCTION OBSERVATIONS

In most cases, other services beyond completion of a geotechnical engineering report are necessary or desirable to complete the project. Occasionally, conditions or circumstances arise that require the performance of additional work that was not anticipated when the geotechnical report was written. PBS offers a range of environmental, geological, geotechnical, and construction services to suit the varying needs of our clients.

PBS should be retained to review the plans and specifications for this project before they are finalized. Such a review allows us to verify that our recommendations and concerns have been adequately addressed in the design.

Satisfactory earthwork performance depends on the quality of construction. Sufficient observation of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. We recommend that PBS be retained to observe general excavation, stripping, fill placement, footing subgrades, and/or installation of piles. Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

6.0 LIMITATIONS

This report has been prepared for the exclusive use of the addressee, and their architects and engineers for aiding in the design and construction of the proposed development and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced, in total or in part, without the expressed written consent of the Client and PBS. It is the addressee's responsibility to provide this report to the appropriate design professionals, building officials and contractors to ensure correct implementation of the recommendations.

The opinions, comments, and conclusions presented in this report are based upon information derived from our literature review, field explorations, laboratory testing, and engineering analyses. Conditions between, or beyond, our explorations may vary from those encountered. It is possible that soil, rock, or groundwater conditions could vary between or beyond the points explored. If soil, rock, or groundwater conditions are encountered during construction that differ from those described herein, the client is responsible for ensuring that PBS is notified immediately so that we may reevaluate the recommendations of this report.

Unanticipated soil and rock conditions and seasonal soil moisture and groundwater variations are commonly encountered and cannot be fully determined by merely taking soil samples or soil borings. Such variations may result in changes to our recommendations and may require additional funds for expenses to attain a properly constructed project. Therefore, we recommend a contingency fund to accommodate such potential extra costs.

The scope of services for this subsurface exploration and geotechnical report did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, if conditions have changed due to natural causes or construction operations at or adjacent to the site, or if the basic project scheme is significantly modified from that assumed, this report should be reviewed to determine the applicability of the conclusions and recommendations presented herein. Land use, site conditions (both on- and off-site), or other factors may change over time and could materially affect our findings. Therefore, this report should not be relied upon after three years from its issue, or in the event that the site conditions change.

7.0 REFERENCES

ASCE. (2005). *Minimum Design Loads for Buildings and Other Structures* (ASCE 7-05)

Beaulieu, J.D. and Hughes, P.W., (1975). *Environmental Geology of Western Coos and Douglas Counties, Oregon.* Oregon Department of Geology and Mineral Industries. Bulletin B-87.

ODOT SS. (2008). *Oregon Standard Specifications for Construction, Volume 2. Salem, Oregon.* Oregon Department of Transportation.

OSSC. (2010). *Oregon Structural Specialty Code.*

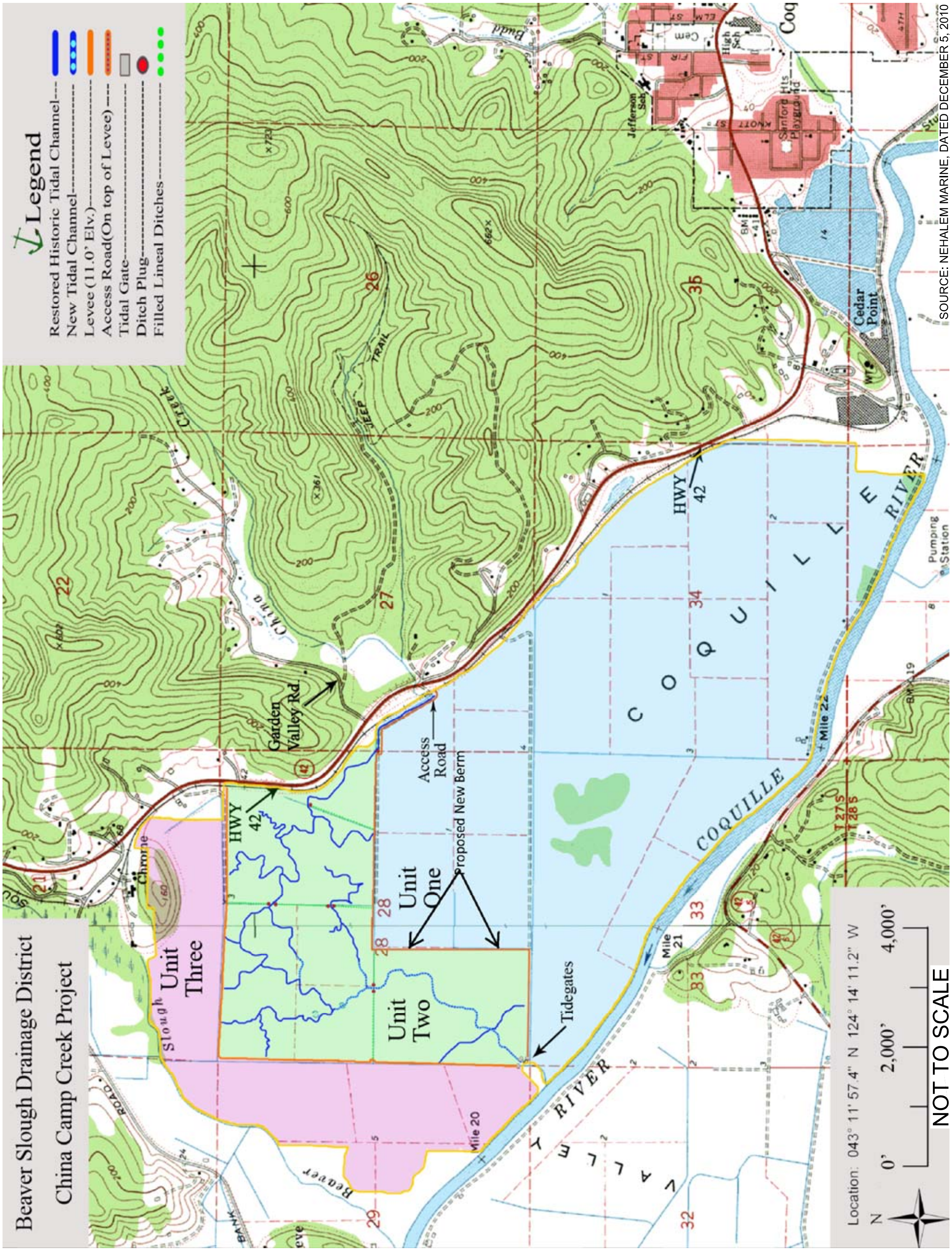
Personius, S.F., (2002). *Fault number 891, South Slough syncline, in Quaternary fault and fold database of the United States.* U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, accessed 06/12/2013 12:09 PM.

Priest, G. R., et al. (2012). *Tsunami Inundation Map, Leneve, Coos County, Oregon.* Oregon Department of Geology and Mineral Industries. TIM-Coos-13.

USACE (2000). *Design and Construction of Berms* (EM 1110-2-1913)

Youd, T.L. et al. (2001). *Liquefaction Resistance of Soil: Summary Report from the 1996 NCEER and 1998 NCEE/NSF Workshops on Evaluation of Liquefaction Resistance of Soils.* Journal of Geotechnical and Geoenvironmental Engineering, 124(10).

FIGURES



SOURCE: NEHALEM MARINE, DATED DECEMBER 5, 2010

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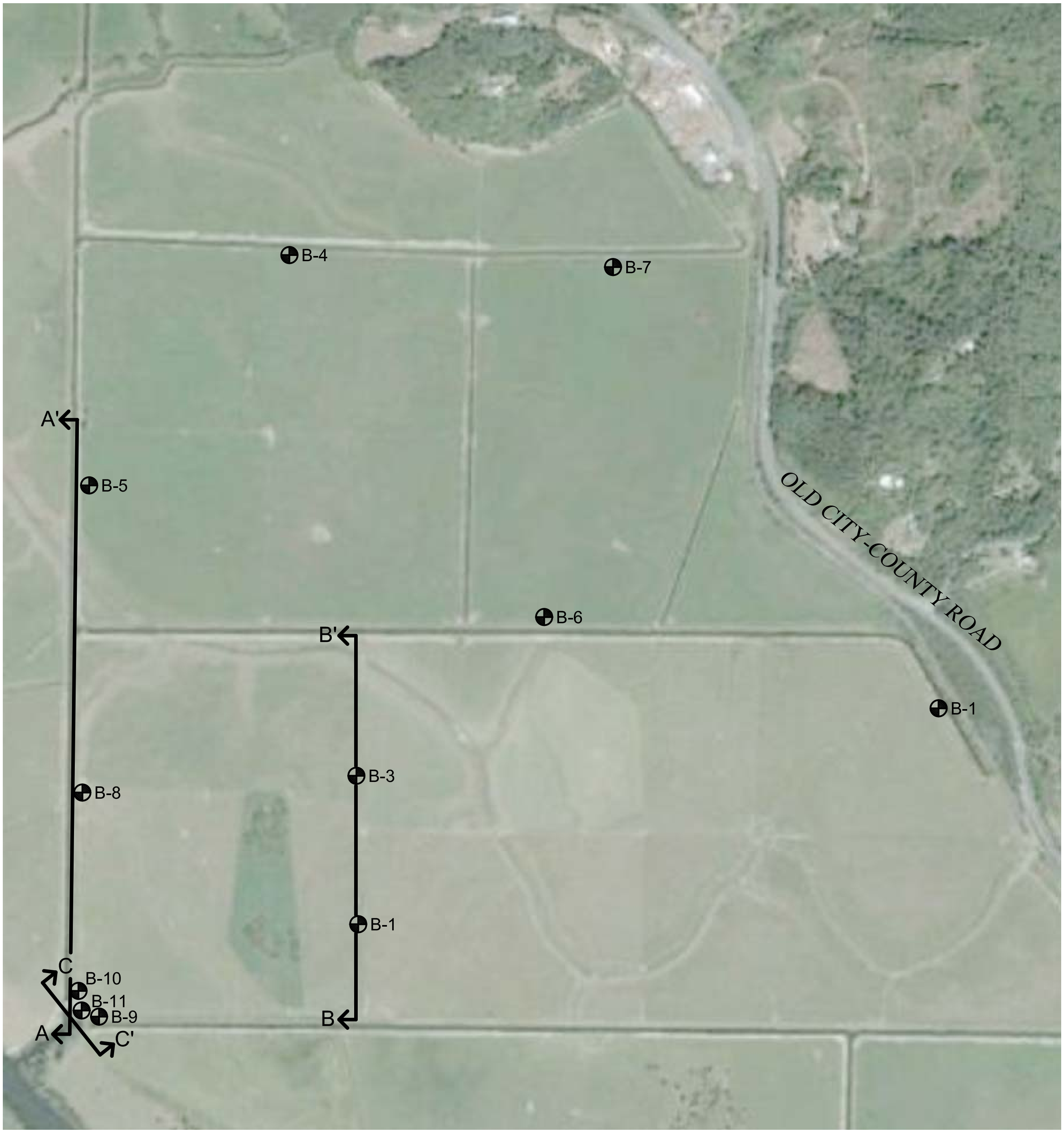
PROJECT #
90190.000

DATE
JUL 2013

VICINITY MAP

CHINA CAMP CREEK
COQUILLE, OREGON

FIGURE
1



SOURCE: © 2011 GOOGLE EARTH PRO, © 2012 GOOGLE

LEGEND

● B-1	BORING NUMBER AND LOCATION
A A'	APPROXIMATE LOCATION OF SUBSURFACE PROFILE

0' 500' 1000' 2000'

SCALE: 1" = 1,000'

PREPARED FOR: NEHALEM MARINE

PBS

PROJECT #
90190.000

DATE
JUL 2013

SITE PLAN AND BORING SAMPLE LOCATIONS

CHINA CAMP CREEK
COQUILLE, OREGON

FIGURE
2

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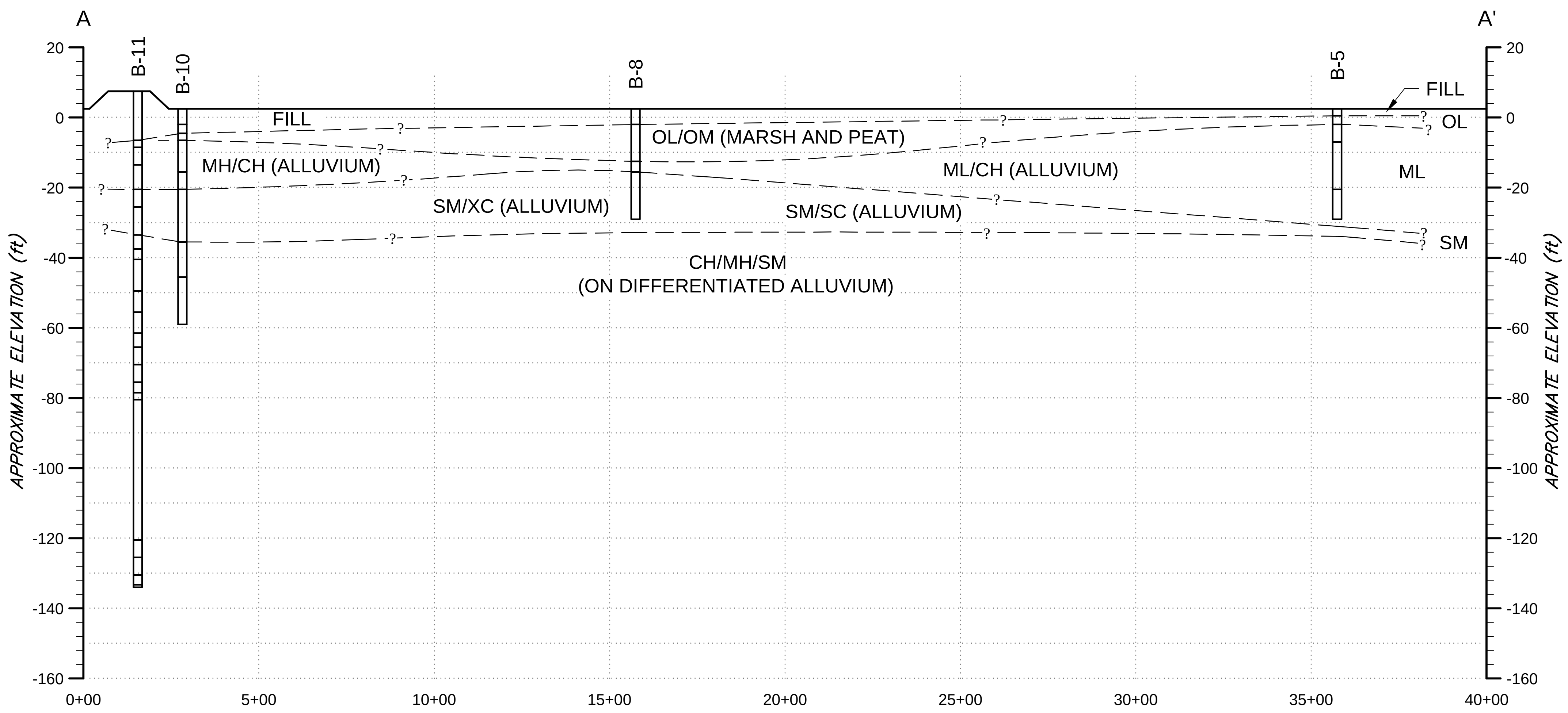

SUBSURFACE PROFILE A-A'

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 20'

NOTE:
1. SITE TOPOGRAPHY IS APPROXIMATE, ACTUAL GROUND SURFACE MAY VARY.
2. CONTACTS BETWEEN UNITS ARE INTERPRETIVE AND MAY REPRESENT A GRADUAL TRANSITION. CONDITIONS MAY VARY BETWEEN BORINGS.

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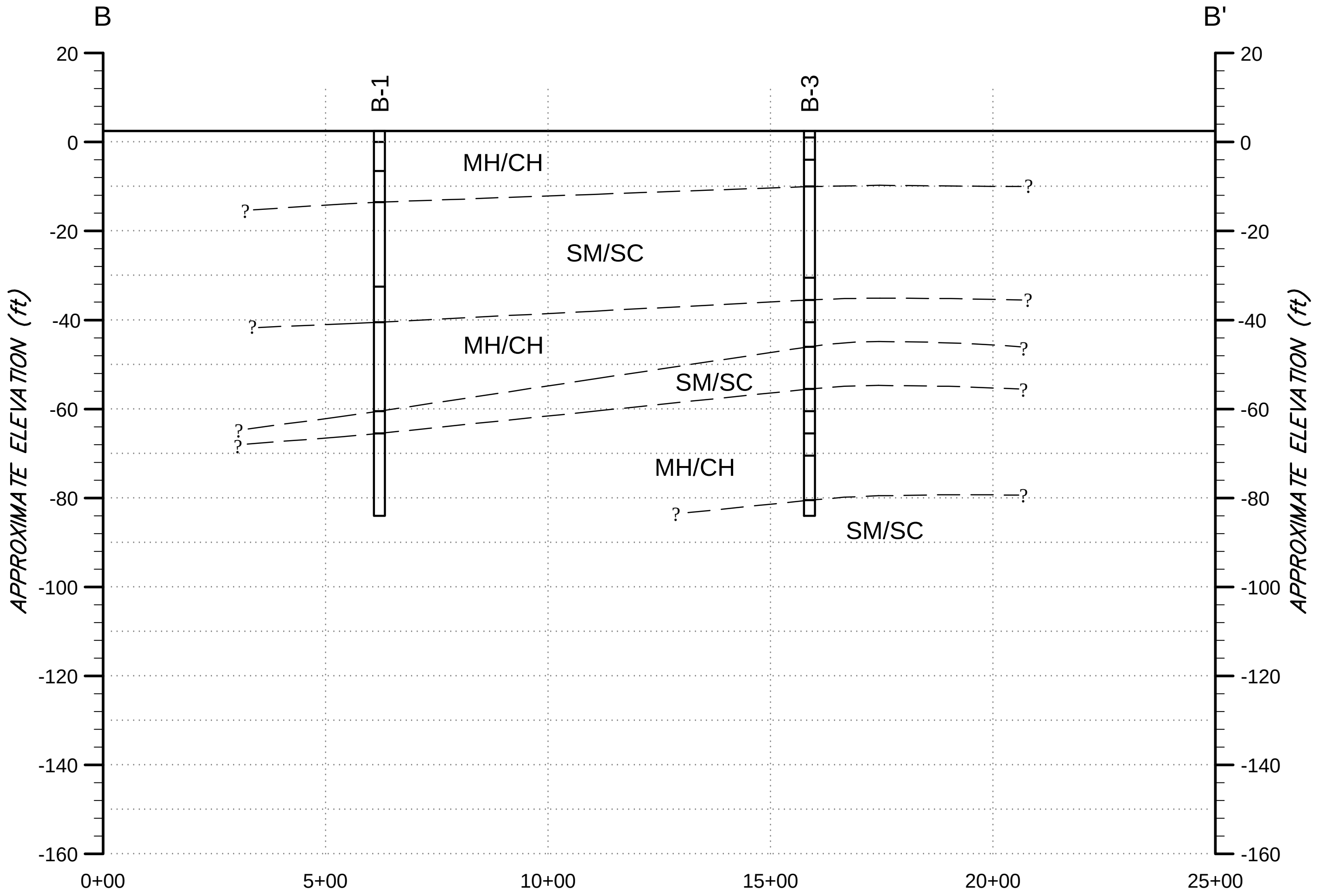
SUBSURFACE PROFILES

CHINA CAMP CREEK
COQUILLE, OREGON

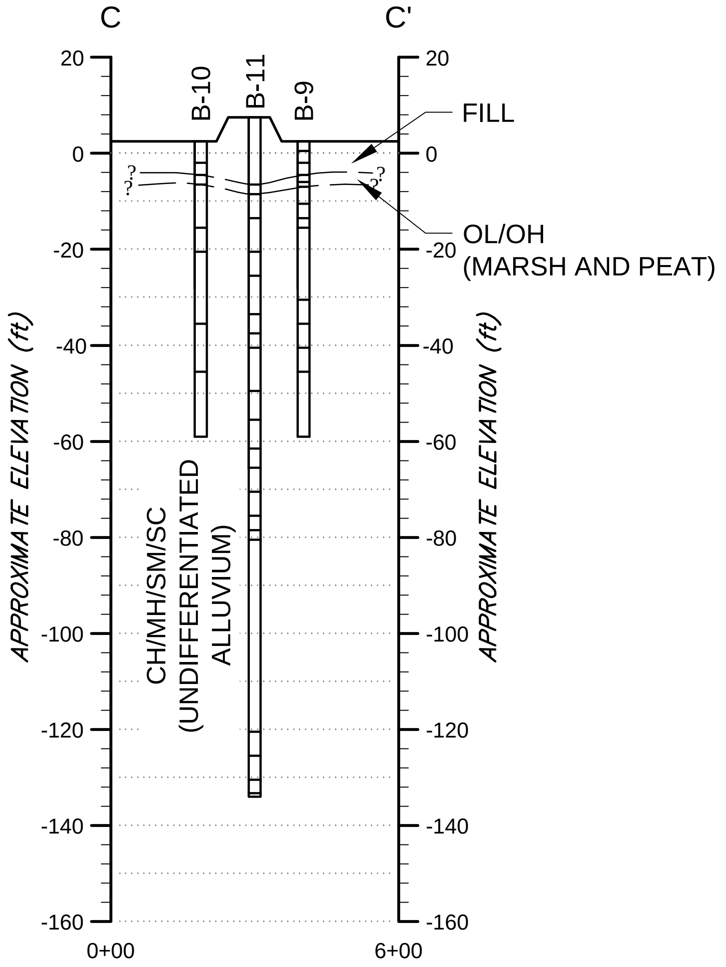
SUBSURFACE
PROFILE A-A'

PROJECT: 90190.000
DATE: AUGUST 2013
FIGURE: 3



SUBSURFACE PROFILE B-B'

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 20'



SUBSURFACE PROFILE C-C'

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 20'

NOTE:
1. SITE TOPOGRAPHY IS APPROXIMATE, ACTUAL GROUND SURFACE MAY VARY.
2. CONTACTS BETWEEN UNITS ARE INTERPRETIVE AND MAY REPRESENT A GRADUAL TRANSITION. CONDITIONS MAY VARY BETWEEN BORINGS.

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SUBSURFACE PROFILES

CHINA CAMP CREEK
COQUILLE, OREGON

SUBSURFACE
PROFILE B-B' & C-C'

PROJECT: 90190.000
DATE: AUGUST 2013
FIGURE:
4

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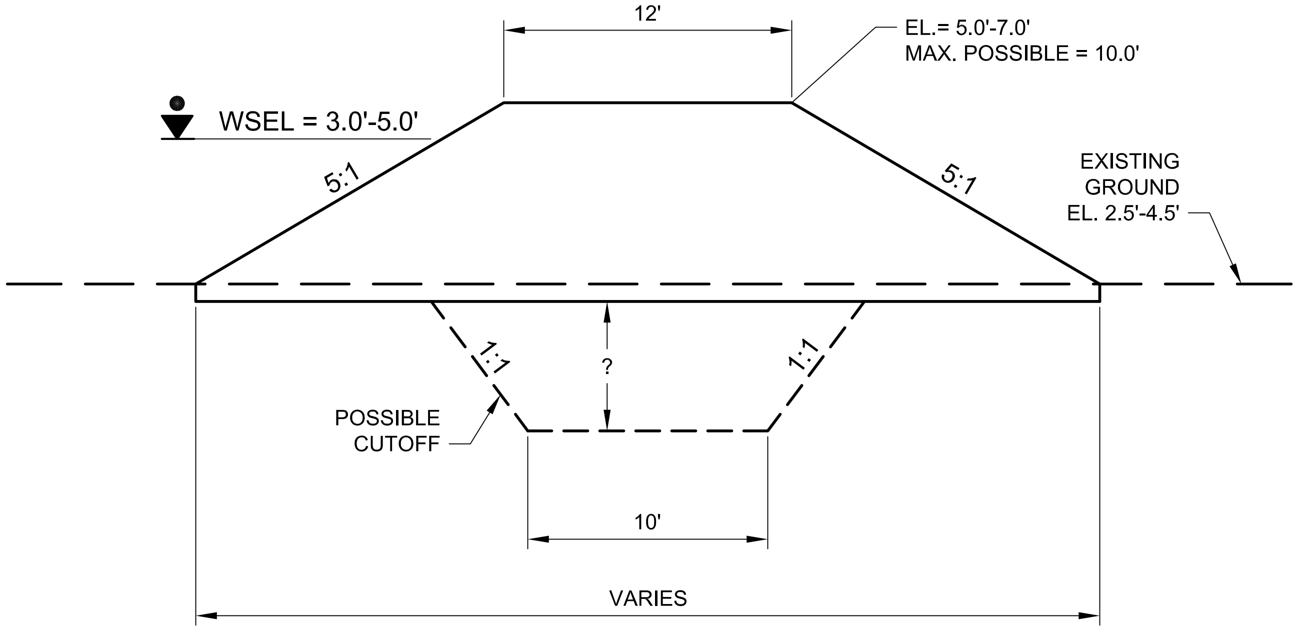

LEVEE CROSS-SECTION

NOT TO SCALE

NOTE:
1. ELEVATIONS ARE CONCEPTUAL, BASED ON NAD88.
2. DESIGN WSEL IS CONCEPTUAL.

PREPARED FOR: NEHALEM MARINE

PBS	PROJECT # 90190.000	TYPICAL LEVEE CROSS-SECTION CHINA CAMP CREEK COQUILLE, OREGON	FIGURE 5
	DATE JUL 2013		

APPENDIX A

Field Explorations

APPENDIX A – FIELD EXPLORATIONS

A1.0 GENERAL

PBS explored subsurface conditions at the project site by advancing eleven (11) borings between November 1 and November 11, 2011. The locations of the explorations, designated Borings B-1 through B-11 are shown on Figure 2. The procedures and techniques used to advance the borings, collect samples, and other field techniques, are described in detail in the following paragraphs. Unless otherwise noted, all soil sampling and classification procedures followed applicable ASTM standards.

A2.0 Borings

A2.1 Drilling

The borings were advanced to depths of up to 141.5 feet below ground surface (bgs) with a track-mounted drill rig provided and operated by Hard Core Drilling, Inc. Borings were advanced using mud-rotary drilling techniques. The borings were observed by a geologist from PBS who located the general areas for drilling and maintained a detailed log of the subsurface conditions and materials encountered during the course of the work.

A2.2 Sampling

Disturbed soil samples were taken in the borings at selected depth intervals. The samples were obtained using a standard 2-inch outside diameter (OD), split-spoon sampler following procedures prescribed for the Standard Penetration Test (SPT). Using the SPT, the sampler is driven 18 inches into the soil using a 140-pound hammer dropped 30 inches. The number of blows required to drive the sampler the last 12 inches is defined as the standard penetration resistance, or N-value. The N-value provides a measure of the relative density of granular soils such as sands and gravels, and the consistency of cohesive soils such as clays and plastic silts. The disturbed soil samples were examined by the PBS geologist and then sealed in plastic bags for further examination and physical testing in our laboratory.

In addition to the SPT samples, relatively undisturbed samples were collected at selected depth intervals. The samples were obtained in a 3-inch OD, thin-wall Shelby tube by hydraulically pushing the tubes into the undisturbed soil at the selected depth. The soils exposed at the ends of the tubes were examined and classified. After field classification, the ends of the tubes were sealed to help preserve the natural moisture of the samples. The sealed tubes were returned to our laboratory for physical testing.

A2.3 Boring Logs

The logs show the various types of materials that were encountered in the borings and the depths where the materials and/or characteristics of these materials changed, although the changes may be gradual. Where material types and descriptions changed between samples, the contacts were interpreted. The types of samples taken during drilling, along with their sample identification number, are shown to the right of the classification of materials. Standard penetration resistances (N-values) and natural water (moisture) contents are shown further to the right. Measured groundwater levels and the dates of the readings are plotted in the column to the right. Any groundwater levels are only for the dates shown and probably vary from time to time during the year.

A4.0 MATERIAL DESCRIPTION

Initially, soil samples were classified visually in the field. Consistency, color, relative moisture, degree of plasticity and other distinguishing characteristics of the soil samples were noted. Afterwards, the samples were re-examined in the PBS laboratory, various standard classification tests were conducted, and the field classifications were modified where necessary. The terminology used in the soil classifications and other modifiers are defined in Appendix A, Terminology Used to Describe Soil.

PBS

Table A-1
Terminology Used to Describe Soil

Soil Descriptions

Soils exist in mixtures with varying proportions of components. The predominant soil, i.e., greater than 50 percent based upon total dry weight, is the primary soil type and is capitalized in our log descriptions, e.g., SAND, GRAVEL, SILT or CLAY. Lesser percentages of other constituents in the soil mixture are indicated by use of modifier words in general accordance with the Visual-Manual Procedure (ASTM D2488-93). “General Accordance” means that certain local and common descriptive practices have been followed. In accordance with ASTM D2488, group symbols (such as GP or CH) are applied on that portion of the soil passing the 3-inch (75mm) sieve based upon visual examination. The following describes the use of soil names and modifying terms used to describe fine- and coarse-grained soils.

Fine - Grained Soils (More than 50% fines passing 0.074 mm, #200 sieve)
The primary soil type, i.e. SILT or CLAY is designated through visual – manual procedures to evaluate soil toughness, dilatency, dry strength, and plasticity. The following describes the terminology used to describe fine - grained soils, and varies from ASTM 2488 terminology in the use of some common terms.

Primary soil NAME, adjective and symbols			**Plasticity Description**	**Plasticity Index (PI)**
SILT ML & MH	CLAY CL & CH	ORGANIC SILT & CLAY OL & OH		
SILT		Organic SILT	Non-plastic	0 - 3
SILT		Organic SILT	Low plasticity	4 - 10
Clayey SILT	Silty CLAY	Organic clayey SILT	Medium Plasticity	>10 – 20
Clayey SILT	CLAY	Organic silty CLAY	High Plasticity	>20 – 40
Clayey SILT	CLAY	Organic CLAY	Very Plastic	>40

Modifying terms describing secondary constituents, estimated to 5 percent increments, are applied as follows:

Description	% Composition
Trace sand, trace gravel	5% - 10%
With sand; with gravel	15% - 25%
Sandy, or gravelly	30% - 45%

Borderline Symbols, for example CH/MH, are used where soils are not distinctly in one category or where variable soil units contain more than one soil type. **Dual Symbols,** for example CL-ML, are used where two symbols are required in accordance with ASTM D2488.

Soil Consistency. Consistency terms are applied to fine-grained, plastic soils (i.e., PI ≥ 7). Descriptive terms are based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586-84, as follows.

Consistency Term	**SPT N-value**	**Unconfined Compressive Strength**	
		Tons/ft^2	**kPa**
Very soft	Less than 2	Less than 0.25	Less than 24
Soft	2 – 4	0.25 - 0.5	24 - 48
Medium stiff	5 – 8	0.5 - 1.0	48 – 96
Stiff	9 – 15	1.0 - 2.0	96 – 192
Very stiff	16 – 30	2.0 - 4.0	192 – 383
Hard	Over 30	Over 4.0	Over 383
Very soft	Less than 2	Less than 0.25	Less than 24

Note: For SILT with low to non-plastic behavior, (i.e., PI < 7) a relative density description is applied.

Table A-1
Terminology Used to Describe Soil
2 of 2

Soil Descriptions

Coarse - Grained Soils (less than 50% fines)
Coarse-grained soil descriptions, i.e., SAND or GRAVEL, are based on that portion of materials passing a 3-inch (75mm) sieve. Coarse-grained soil group symbols are applied in accordance with ASTM D2488 based upon the degree of grading, or distribution of grain sizes of the soil. For example, well graded sand containing a wide range of grain sizes is designated SW; poorly graded gravel, GP, contains high percentages of only certain grain sizes. Terms applied to grain sizes follow.

Material	Particle Diameter Inches	 Millimeters
Sand (S)	0.003 - 0.19	0.075 - 4.8
Gravel (G)	0.19 - 3.0	4.8 - 75
	Additional Constituents	
Cobble	3.0 - 12	75 - 300
Boulder	12 - 120	300 - 3050
Rock Block	>120	>3050

The primary soil type is capitalized, and the amount of fines in the soil are described as indicated by the following examples. Other soil mixtures will provide similar descriptive names.

Example: Coarse-Grained Soil Descriptions with Fines

5% fines	10% fines (Dual Symbols)	15% to 45% fines
GRAVEL with trace silt: GW or GP	GRAVEL with silt, GW-GM	Silty GRAVEL: GM
SAND with trace clay: SW or SP	SAND with clay, SP-SC	Silty SAND: SM

Additional descriptive terminology applied to coarse-grained soils follow.

Coarse-Grained Soil Containing Secondary Constituents

Clean	< 5% fines
With sand or with gravel	15% - 25% sand or gravel
Sandy or gravelly	30% - 45% sand or gravel
With cobbles; with boulders	Any amount cobbles or boulders. Additional terms may be used to describe amount including abundant, scattered.

Cobble and boulder deposits may include a description of the matrix soils, as defined above.

Relative Density terms are applied to granular, non-plastic soils based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586-84.

Relative Density Term	SPT N-value
Very loose	0 - 4
Loose	4 - 10
Medium dense	10 - 30
Dense	30 - 50
Very dense	> 50

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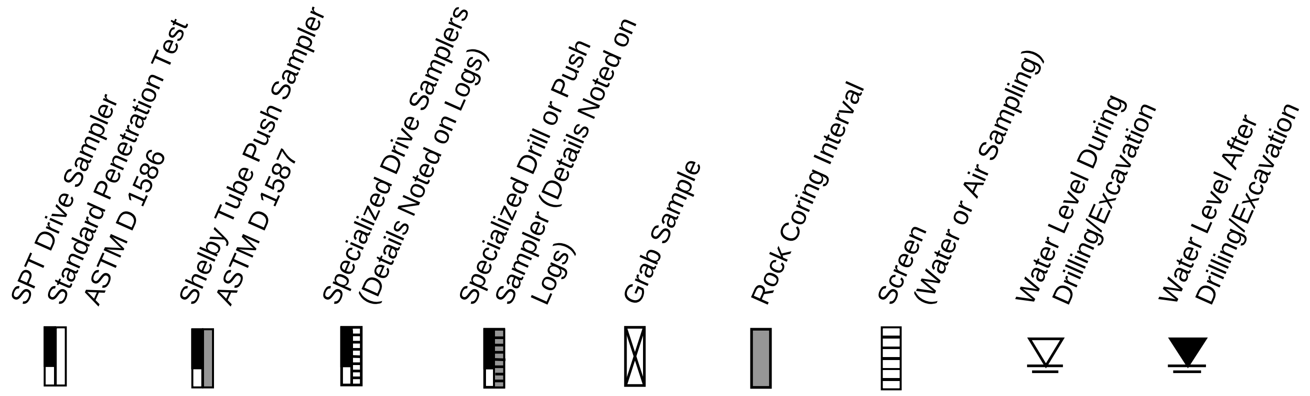
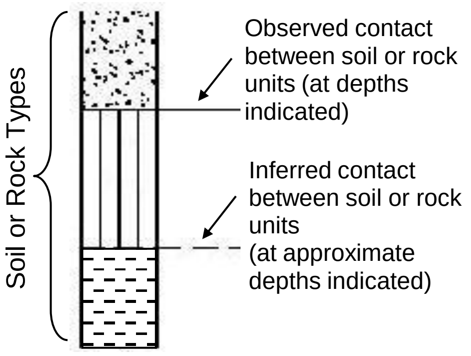
Table A-2
Key To Test Pit and Boring Log Symbols

SAMPLING DESCRIPTIONS[1]

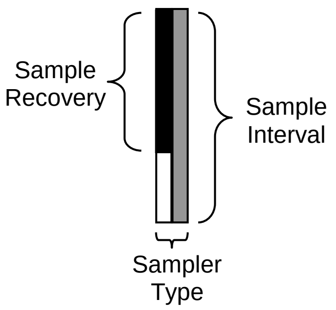


LOG GRAPHICS

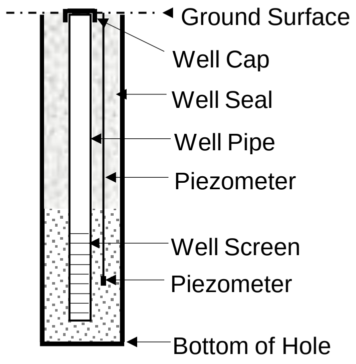
Soil and Rock



Sampling Symbols



Instrumentation Detail



Geotechnical Testing/Acronym Explanations

PP	Pocket Penetrometer	SIEV	Sieve Gradation
SC	Sand Cone	DD	Dry Density
DCP	Dynamic Cone Penetrometer	ATT	Atterberg Limits
SP	Static Penetrometer	CBR	California Bearing Ratio
TOR	Torvane	OC	Organic Content
CON	Consolidation	RES	Resilient Modulus
DS	Direct Shear	VS	Vane Shear
P200	Percent Passing U.S. Standard No. 200 Sieve	HCL	Hydrochloric Acid
UC	Unconfined Compressive Strength	kPa	kiloPascal
PL	Plasticity Limit	GPS	Global Positioning System
PI	Plasticity Index	bgs	Below ground surface
LL	Liquid Limit	MSL	Mean Sea Level
HYD	Hydrometer Gradation		

Environmental Testing/Acronym Explanations

bgs	Below ground surface	ATD	At Time of Drilling
CA	Sample Submitted for Chemical Analysis	NS	No Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
PPM	Parts Per Million	MS	Moderate Sheen
ND	Not Detected	HS	High Sheen

[1] Note: Details of soil and rock classification systems are available on request.

Rev. 04/30/13

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CHINA CAMP CREEK
COQUILLE, OREGON

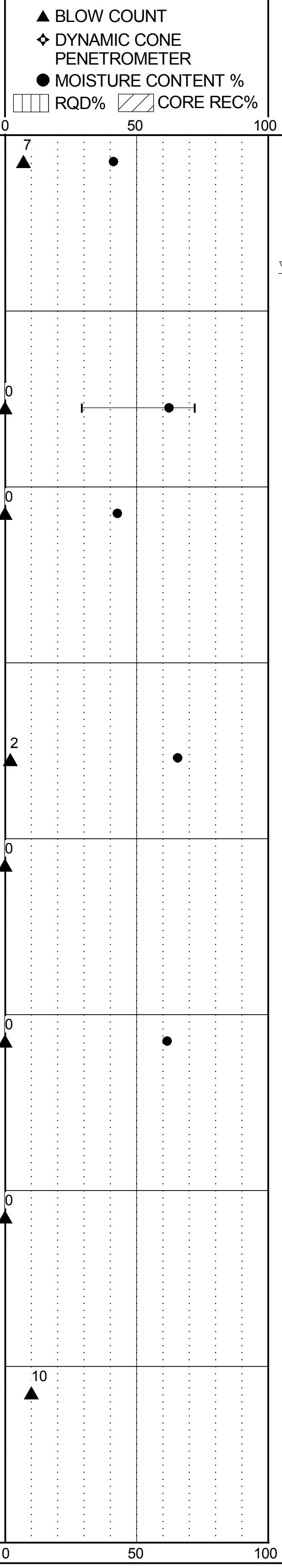
PBS PROJECT NUMBER:
90190.000

BORING B-1

APPROX. BORING B-1 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
0.0	2-inch-thick ROOT ZONE	0.0				
	Medium stiff, light brown, clayey SILT with trace organics; dry to moist	0.2		S-1	7	
	Very soft, gray, CLAY with some silt and trace organics; wet, high plasticity	2.5				Driller missed 2.5-ft sample
						⊻ 11/01/11 Inferred
5.0			CON	S-2		
			ATT VS	S-3	0	LL = 72% PL = 29% PI = 43% VS = 0.0 tsf
	becomes CLAY with trace sand and organics and trace silt					
10.0			P200	S-4	0	P200 = 66%
15.0						
	Very soft to soft, gray, SILT with some clay and trace fine sand and organics; moist to wet, high plasticity	16.0		S-5		
			VS	S-6	2	VS = 0.5 tsf
20.0				S-7	0	
	grades to brown-gray					
25.0				S-8	0	
30.0				S-9	0	
35.0	Loose to medium dense, dark gray, silty fine to medium SAND with trace organics; wet, high plasticity fines	35.0		S-10	10	Driller's comment: formation change right at 35.0 ft
40.0						



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/01/11

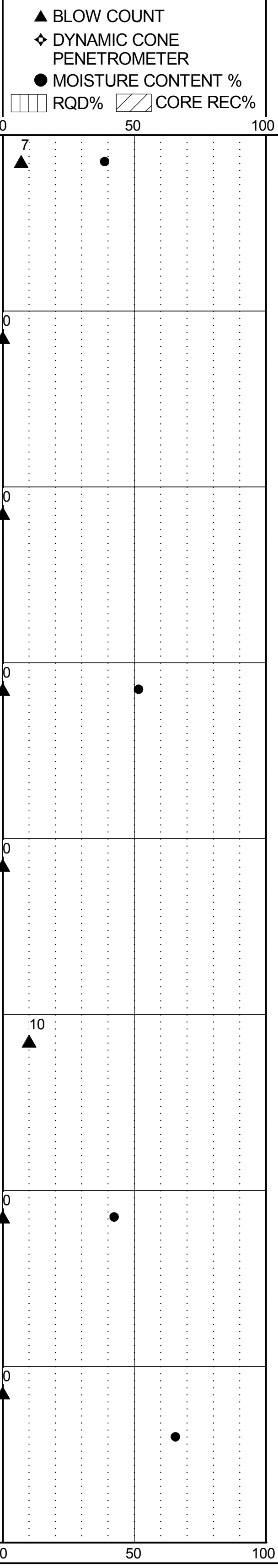
FIGURE A1

BORING B-1
(continued)

APPROX. BORING B-1 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	SAMPLE ID	BLOW COUNT
40.0	Loose to medium dense, dark gray, fine to medium SAND with trace silt and organics; wet		S-11	7
	Very soft, brown-gray, SILT with some clay to clayey SILT; moist, high plasticity	43.0		
45.0			S-12	0
50.0	trace fine sand		S-13	0
55.0			S-14	0
60.0			S-15	0
	Loose to medium dense, gray, silty fine to medium SAND; wet, high plasticity fines	63.0		
65.0			S-16	10
	Very soft, brown-gray, SILT with some clay and trace sand; moist to wet, high plasticity, few sand laminae up to ¼-inch thick	68.0		
70.0			S-17	0
75.0			S-18	0
80.0				



INSTALLATION AND COMMENTS

DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/01/11

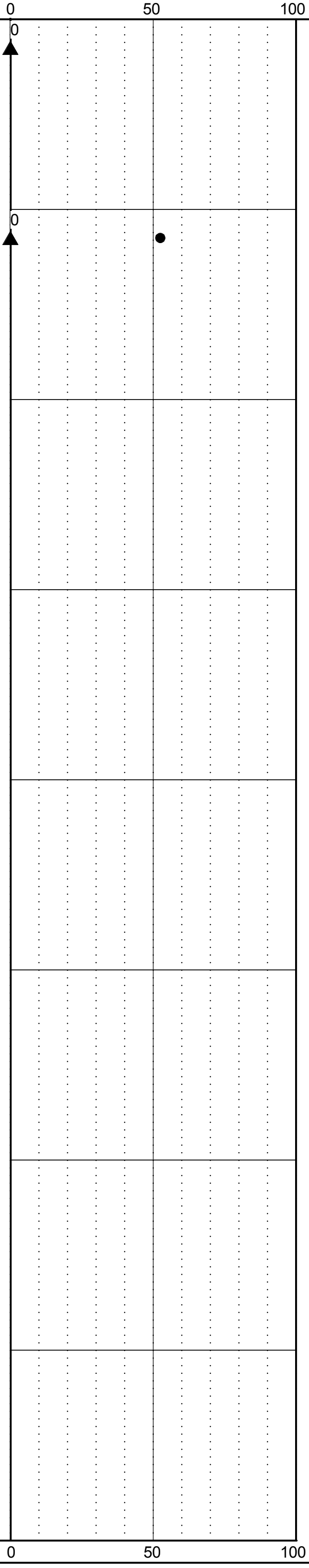
BORING B-1
(continued)

APPROX. BORING B-1 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD% ▨ CORE REC%

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	INSTALLATION AND COMMENTS
80.0		Very soft, brown-gray, SILT with some clay and trace sand; moist to wet, few sand laminae up to ¼-inch thick	80.0		S-19	
85.0					S-20	
		Final depth 86.5 feet; boring backfilled with bentonite grout and chips	86.5			
90.0						
95.0						
100.0						
105.0						
110.0						
115.0						
120.0						



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/01/11

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CHINA CAMP CREEK
COQUILLE, OREGON

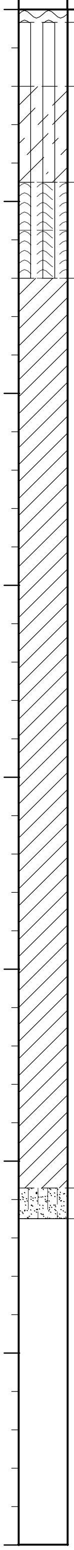
BORING B-2

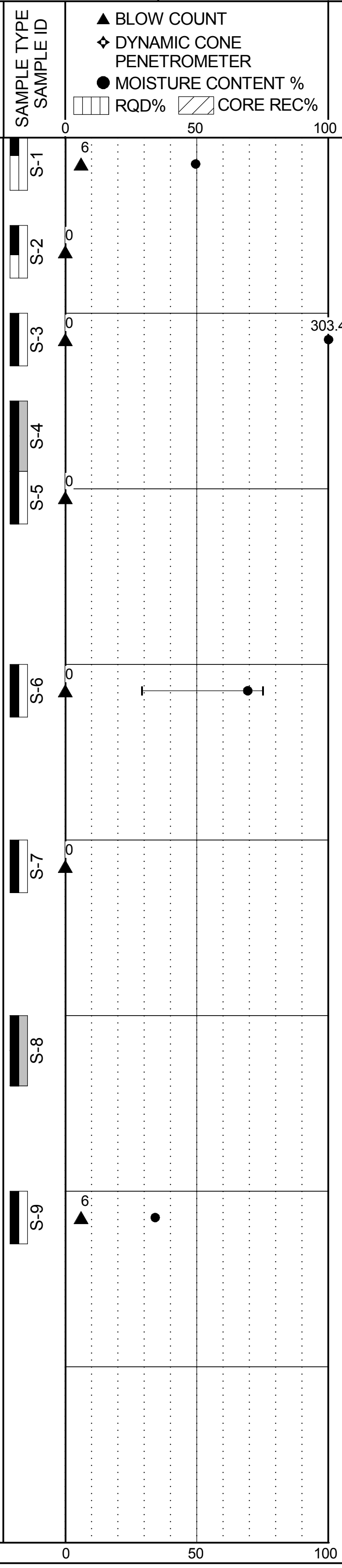
PBS PROJECT NUMBER:
90190.000

APPROX. BORING B-2 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH	MATERIAL DESCRIPTION	TESTING	INSTALLATION AND COMMENTS
0.0 0.3	4-inch-thick ROOT ZONE		
0.3 2.0	Soft to medium stiff, light brown, SILT with some clay; dry		
2.0 4.5	Very soft, brown, clayey SILT with trace organics; wet		
4.5 7.0	Very soft, dark brown, ORGANIC SILT; wet		
7.0 30.7	Very soft, gray, CLAY with trace to some silt and trace sand and organics; wet; to silty CLAY with trace fine sand and organics; wet, high plasticity	CON VS	VS = 0.0 tsf
		ATT	LL = 75% PL = 29% PI = 46%
		CON VS	VS = 0.0 tsf
	color change to dark gray		
30.7 31.5	Loose, dark gray, silty fine SAND with trace organics; wet, high plasticity fines		
31.5	Final depth 31.5 feet bgs; boring backfilled with bentonite chips		





DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/02/11

FIGURE A2
Page 1 of 1

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CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

BORING B-3

APPROX. BORING B-3 LOCATION:
(See Site Plan)

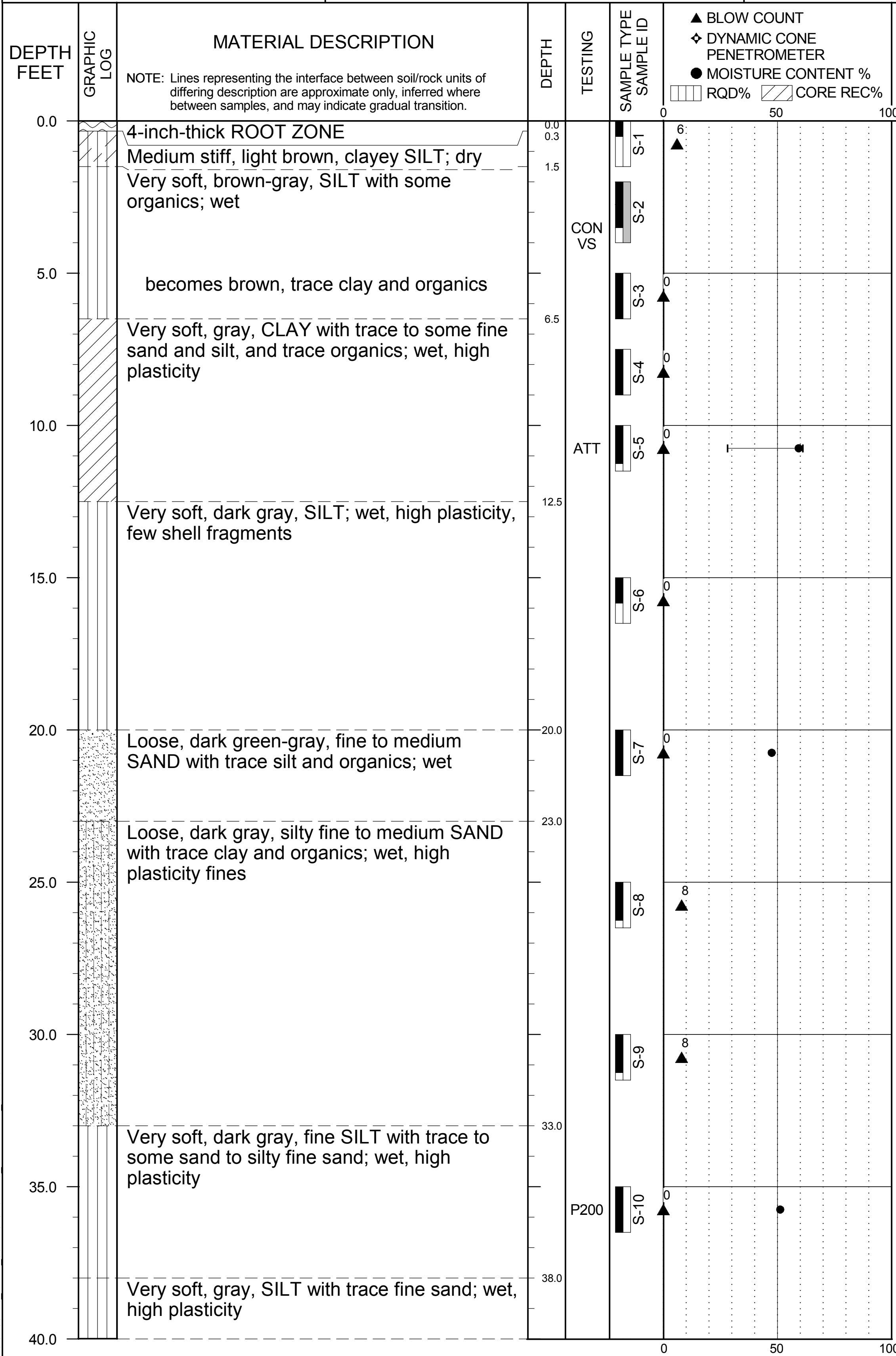
MATERIAL DESCRIPTION

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH	MATERIAL DESCRIPTION
0.0	4-inch-thick ROOT ZONE
0.3	Medium stiff, light brown, clayey SILT; dry
1.5	Very soft, brown-gray, SILT with some organics; wet becomes brown, trace clay and organics
6.5	Very soft, gray, CLAY with trace to some fine sand and silt, and trace organics; wet, high plasticity
12.5	Very soft, dark gray, SILT; wet, high plasticity, few shell fragments
20.0	Loose, dark green-gray, fine to medium SAND with trace silt and organics; wet
23.0	Loose, dark gray, silty fine to medium SAND with trace clay and organics; wet, high plasticity fines
33.0	Very soft, dark gray, fine SILT with trace to some sand to silty fine sand; wet, high plasticity
38.0	Very soft, gray, SILT with trace fine sand; wet, high plasticity

SAMPLE ID	TESTING	BLOW COUNT	INSTALLATION AND COMMENTS
S-1		6	
S-2	CON VS		VS = 0.0 tsf
S-3		0	
S-4		0	
S-5	ATT	0	LL = 61% PL = 28% PI = 33%
S-6		0	
S-7		0	
S-8		8	
S-9		8	
S-10	P200	0	P200 = 83%

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/03/11

FIGURE A3

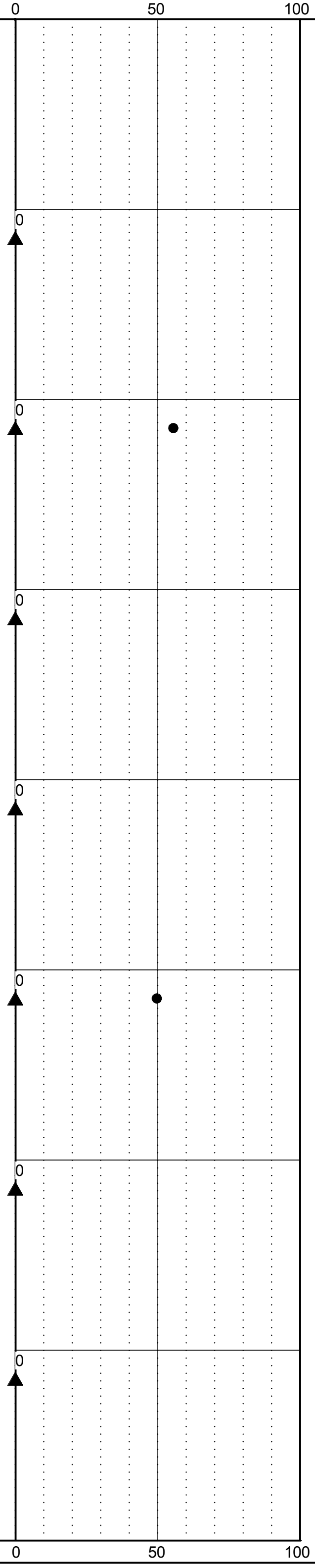
BORING B-3
(continued)

APPROX. BORING B-3 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
40.0	Very soft, gray, SILT with trace fine sand; wet, high plasticity	40.0	VS	S-11		VS = 0.25 tsf
45.0				S-12	0	
	Very soft, gray, SILT with some fine sand trace organics, and shell fragments; wet, high plasticity	48.5				
50.0				S-13	0	
55.0				S-14	0	
	Very soft, gray, SILT with trace sand and clay; wet, thinly interbedded with very loose, gray, fine to medium SAND with trace silt, organics, and shell fragments; wet, high plasticity	58.0				
60.0				S-15	0	
	Very soft, dark brown-gray, silty CLAY to clayey SILT with trace organics and shell fragments; wet, high plasticity	63.0				
65.0				S-16	0	
	Very soft, gray, SILT with trace sand, clay, and organics; wet, high plasticity	68.0				
70.0				S-17	0	
	Very soft, dark brown-gray, SILT with some clay and trace organics; wet, high plasticity	73.0				
75.0				S-18	0	
80.0						Driller's comment: feels like interbedded sand and silt from 78 ft bgs to 85 ft bgs



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/03/11

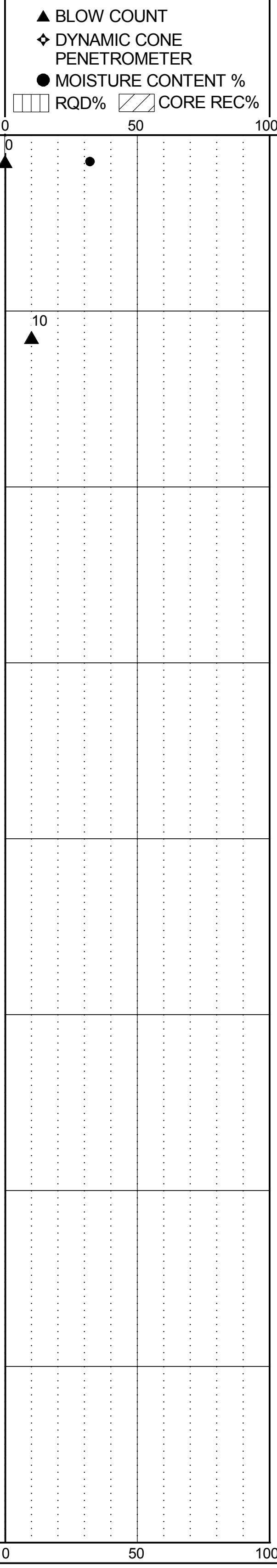
FIGURE A3

BORING B-3
(continued)

APPROX. BORING B-3 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	INSTALLATION AND COMMENTS
80.0	Very soft, dark brown-gray, SILT with some clay and trace organics; wet, high plasticity	80.0		S-19	
	Loose to medium dense, gray, silty fine to medium SAND; wet, high plasticity fines	83.0			
85.0				S-20	
	Final depth 86.5 feet bgs; boring backfilled with bentonite grout and chips	86.5			
90.0					
95.0					
100.0					
105.0					
110.0					
115.0					
120.0					



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/03/11

FIGURE A3

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CHINA CAMP CREEK
COQUILLE, OREGON

BORING B-4

PBS PROJECT NUMBER:
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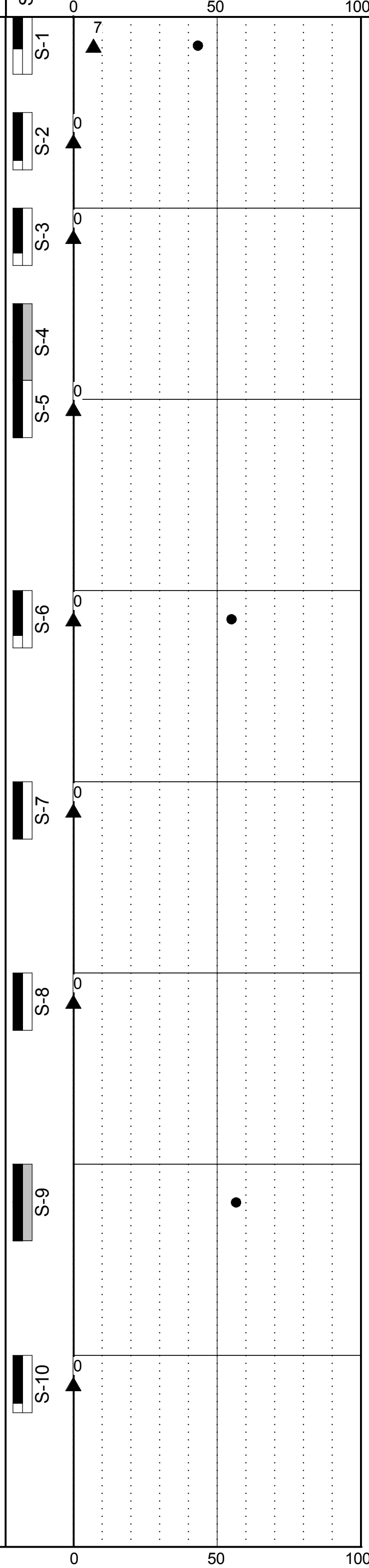
APPROX. BORING B-4 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH
0.0	Medium stiff, light brown with rust mottles, SILT with some clay and trace organics; dry	0.0
2.5	Very soft, brown, silty CLAY to clayey SILT with trace organics; wet	2.5
5.0	Very soft, brown-gray, SILT with trace to some clay; wet, high plasticity	5.0
10.0	becomes gray, SILT with trace organics	
15.0	becomes SILT with trace fine sand and trace organics	
18.0	Very soft, brown-gray, SILT with trace to some clay and organics; wet, high plasticity	18.0
28.0	Very soft, gray, SILT with trace organics; wet, high plasticity	28.0
35.0	becomes SILT with trace organics and shell fragments; few thin laminae of fine sand	
40.0		

TESTING	SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
	S-1	7	
			⊻ Groundwater level (inferred from samples)
	S-2	0	
	S-3	0	
CON	S-4		
	S-5	0	4" peat on top of sample; possible slough
P200	S-6	0	P200 = 91%
	S-7	0	
	S-8	0	
VS	S-9		VS = 0.5 tsf
	S-10	0	

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/04/11

FIGURE A4

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CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
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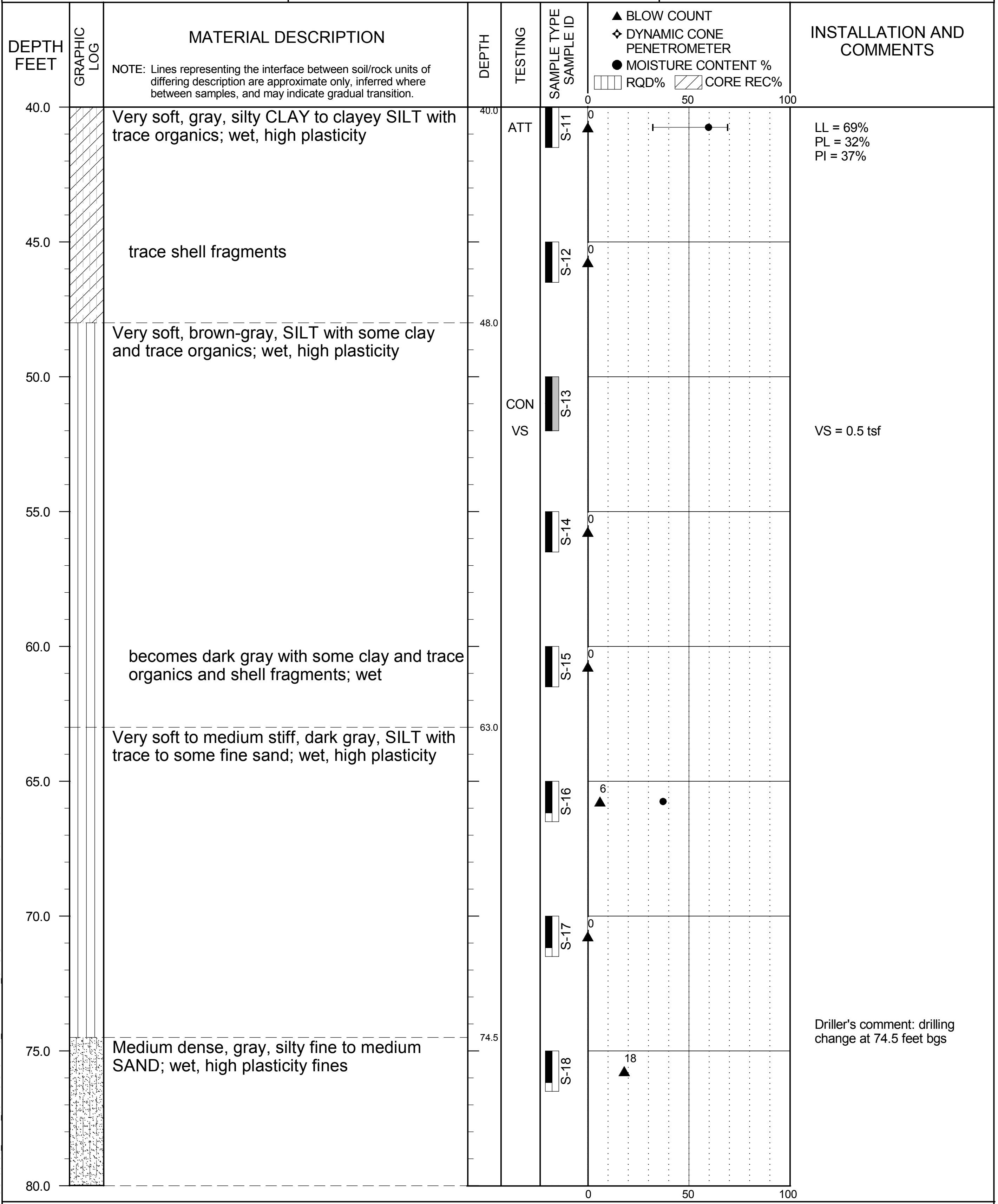
BORING B-4
(continued)

APPROX. BORING B-4 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.



DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	▲ BLOW COUNT	INSTALLATION AND COMMENTS
40.0	Very soft, gray, silty CLAY to clayey SILT with trace organics; wet, high plasticity	40.0	ATT	S-11	0	LL = 69% PL = 32% PI = 37%
45.0	trace shell fragments			S-12	0	
	Very soft, brown-gray, SILT with some clay and trace organics; wet, high plasticity	48.0				
50.0			CON VS	S-13		VS = 0.5 tsf
55.0				S-14	0	
60.0	becomes dark gray with some clay and trace organics and shell fragments; wet			S-15	0	
	Very soft to medium stiff, dark gray, SILT with trace to some fine sand; wet, high plasticity	63.0				
65.0				S-16	6	
70.0				S-17	0	
	Medium dense, gray, silty fine to medium SAND; wet, high plasticity fines	74.5				Driller's comment: drilling change at 74.5 feet bgs
75.0				S-18	18	
80.0						

DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/04/11

BORING LOG 90190 B1-11 081413.GPJ PBS DATATMPL GEO.GDT PRINT DATE: 8/15/13:RSD

FIGURE A4

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CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

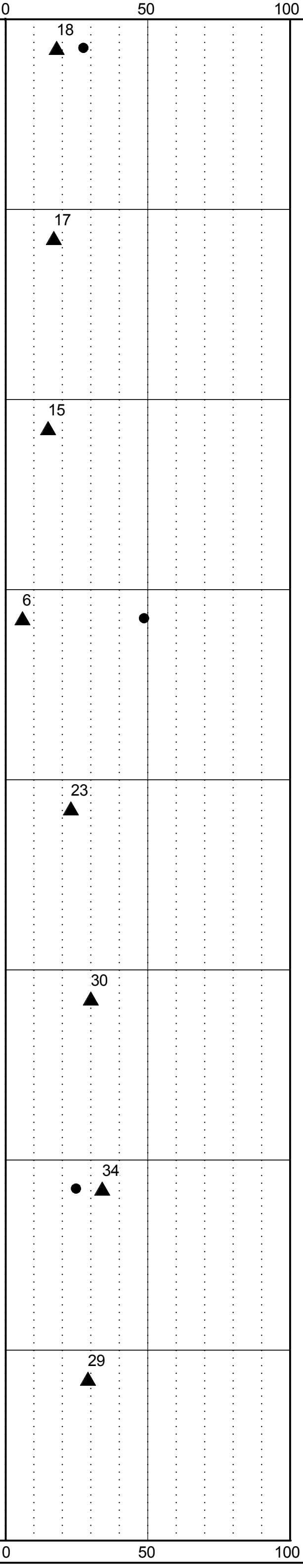
BORING B-4
(continued)

APPROX. BORING B-4 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
80.0	Medium dense, gray, silty fine to medium SAND; wet, high plasticity fines	80.0	S-19	18	
85.0	trace organics (wood debris) and shell fragments		S-20	17	
90.0			S-21	15	
95.0	becomes loose		S-22	6	
100.0	becomes medium dense		S-23	23	Driller's comment: formation becomes steadilty harder between 100.0 and 105.0 feet bgs
105.0	Medium dense to dense, gray, SAND with trace fine gravel and silt; wet	105.0	S-24	30	
110.0			S-25	34	
115.0			S-26	29	
120.0					



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/04/11

FIGURE A4

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CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
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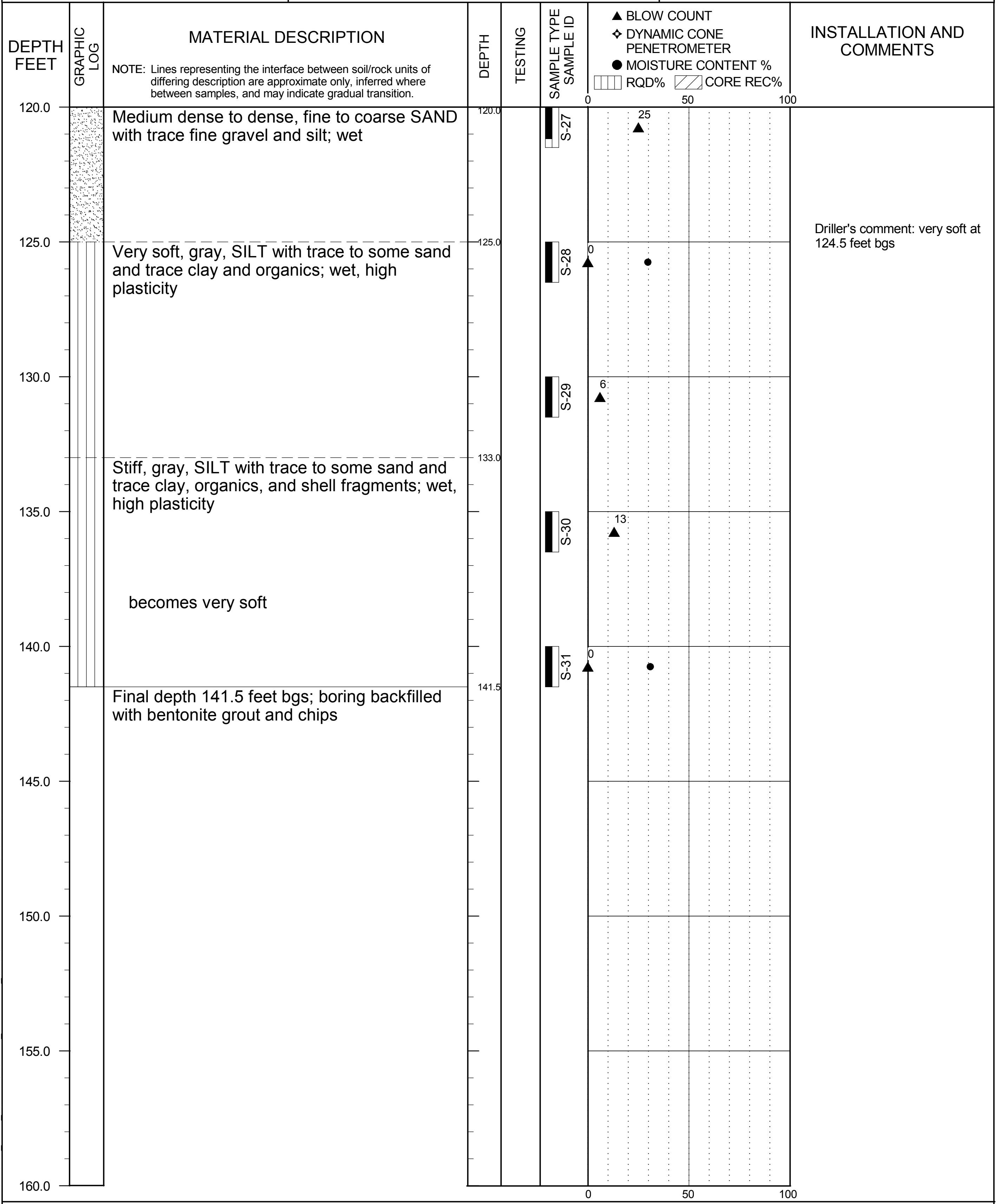
BORING B-4
(continued)

APPROX. BORING B-4 LOCATION:
(See Site Plan)



NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH	MATERIAL DESCRIPTION	SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
120.0	Medium dense to dense, fine to coarse SAND with trace fine gravel and silt; wet	S-27	25	
125.0	Very soft, gray, SILT with trace to some sand and trace clay and organics; wet, high plasticity	S-28	0	Driller's comment: very soft at 124.5 feet bgs
		S-29	6	
133.0	Stiff, gray, SILT with trace to some sand and trace clay, organics, and shell fragments; wet, high plasticity	S-30	13	
	becomes very soft	S-31	0	
141.5	Final depth 141.5 feet bgs; boring backfilled with bentonite grout and chips			

DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/04/11

FIGURE A4

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CHINA CAMP CREEK
COQUILLE, OREGON

BORING B-5

PBS PROJECT NUMBER:
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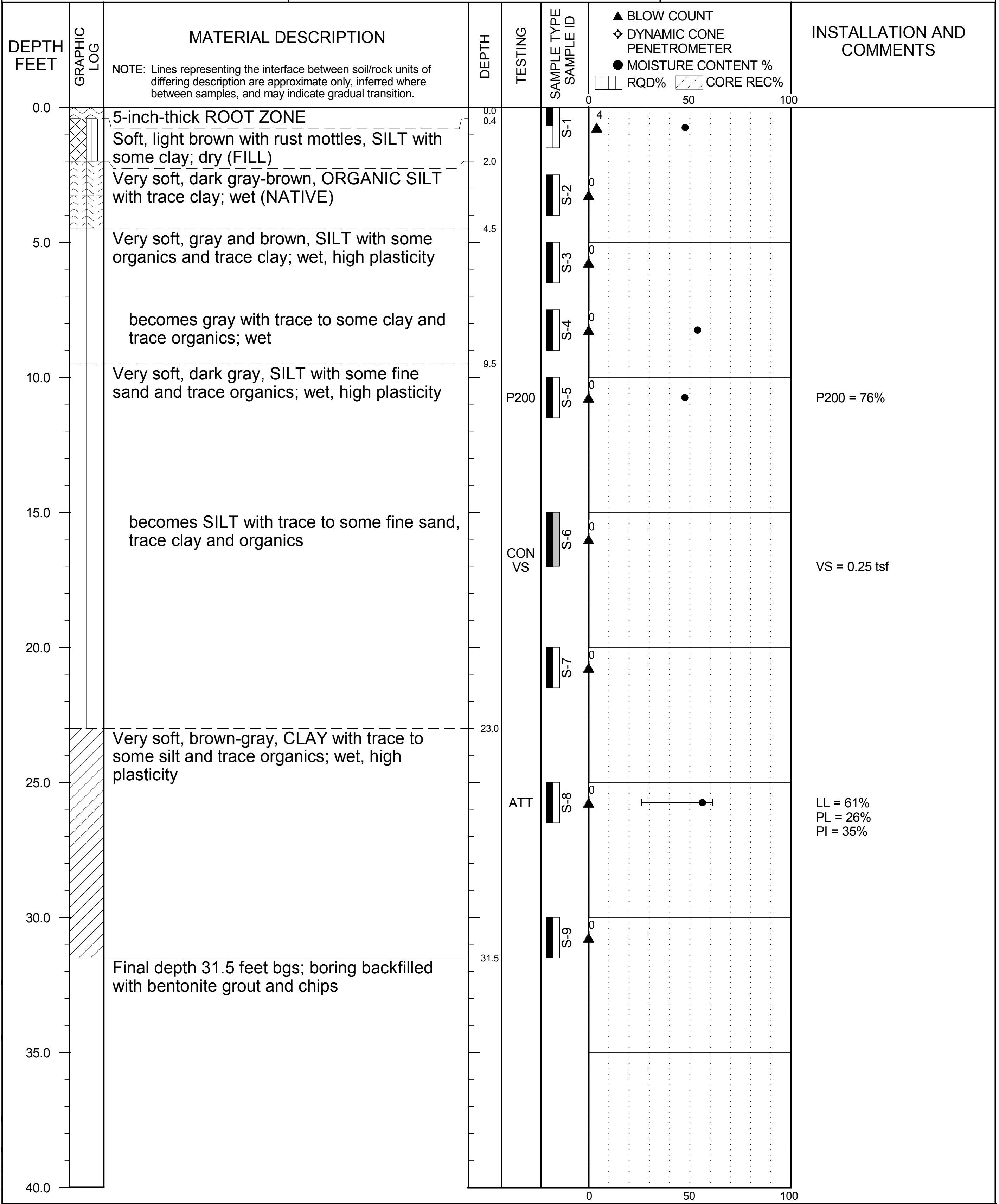
APPROX. BORING B-5 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.



DEPTH	MATERIAL DESCRIPTION	TESTING	SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
0.0	5-inch-thick ROOT ZONE				
0.4	Soft, light brown with rust mottles, SILT with some clay; dry (FILL)		S-1	4	
2.0	Very soft, dark gray-brown, ORGANIC SILT with trace clay; wet (NATIVE)		S-2	0	
4.5	Very soft, gray and brown, SILT with some organics and trace clay; wet, high plasticity		S-3	0	
	becomes gray with trace to some clay and trace organics; wet		S-4	0	
9.5	Very soft, dark gray, SILT with some fine sand and trace organics; wet, high plasticity	P200	S-5	0	P200 = 76%
	becomes SILT with trace to some fine sand, trace clay and organics	CON VS	S-6	0	VS = 0.25 tsf
			S-7	0	
23.0	Very soft, brown-gray, CLAY with trace to some silt and trace organics; wet, high plasticity	ATT	S-8	0	LL = 61% PL = 26% PI = 35%
			S-9	0	
31.5	Final depth 31.5 feet bgs; boring backfilled with bentonite grout and chips				

DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/05/11

FIGURE A5

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CHINA CAMP CREEK
COQUILLE, OREGON

BORING B-6

PBS PROJECT NUMBER:
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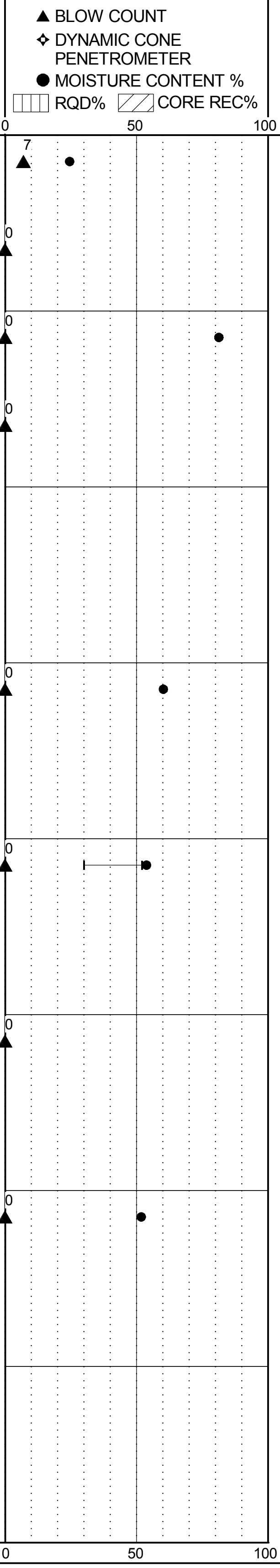
APPROX. BORING B-6 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
0.0	1-inch-thick ROOT ZONE	0.0				
	Medium stiff, light brown with rust mottles, SILT with trace to some clay; dry (FILL)	0.1		S-1	7	
	Very soft, tan and rust mottled, SILT with trace to some clay; dry (FILL)	2.0		S-2	0	
5.0				S-3	0	
	Very soft, dark brown-gray, SILT with trace to some organics and clay; wet (NATIVE)	6.0		S-4	0	
10.0	becomes trace clay		CON VS	S-5		VS = 0.5 tsf
	Very soft, gray and brown, sandy SILT with some organics to fine SAND with some silt and organics; wet, high plasticity fines, abundant wood fragments	13.0				
15.0			P200	S-6	0	P200 = 43%
	Very soft, brown-gray, SILT with some clay and trace organics and shell fragments; wet, high plasticity	18.0				
20.0			ATT	S-7	0	LL = 52% PL = 30% PI = 22%
25.0	becomes trace to some clay			S-8	0	
30.0	becomes dark gray, trace clay			S-9	0	
	Final depth 31.5 feet bgs; boring backfilled with bentonite chips	31.5				
35.0						
40.0						



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/05/11

FIGURE A6
Page 1 of 1

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CHINA CAMP CREEK
COQUILLE, OREGON

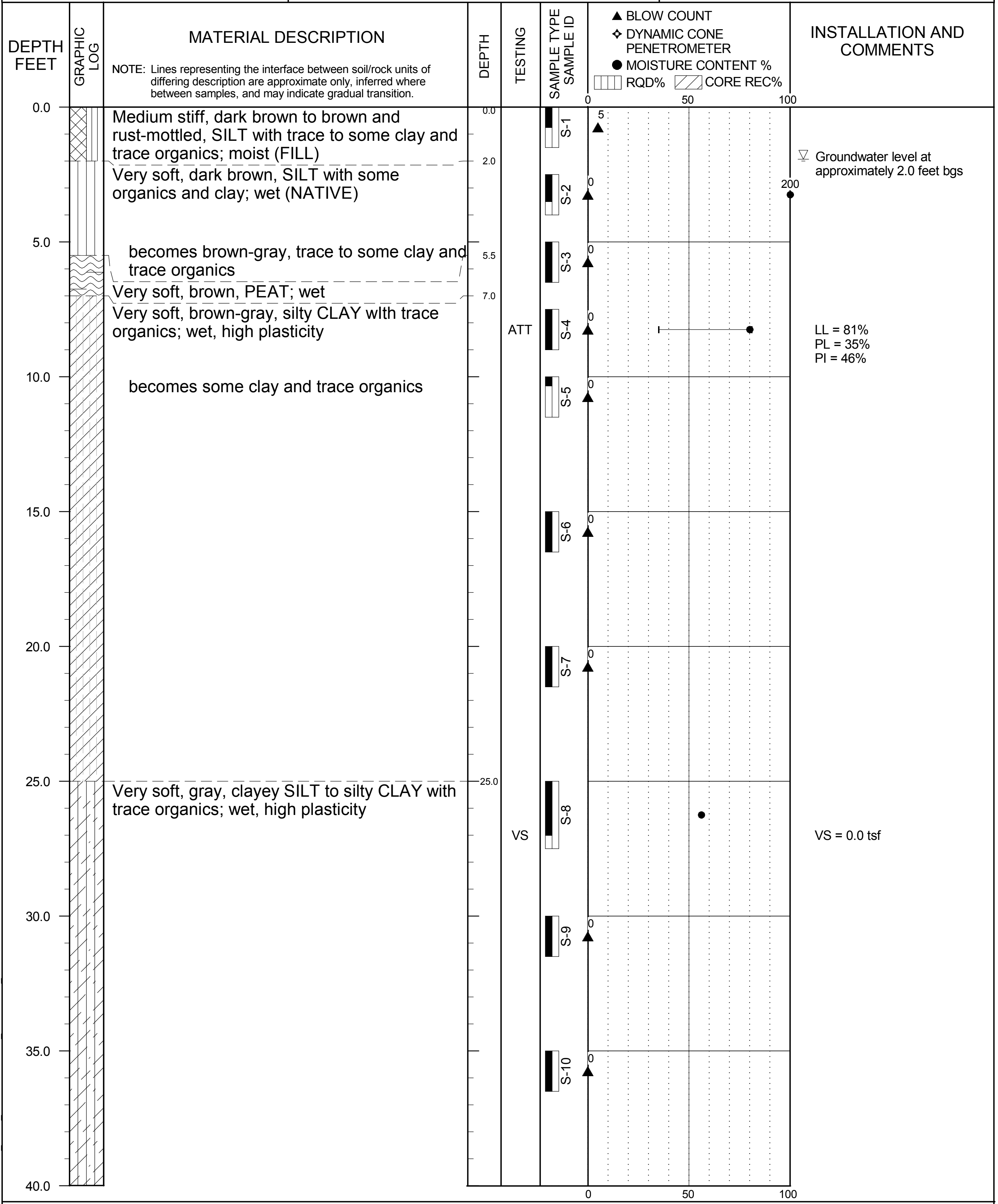
BORING B-7

PBS PROJECT NUMBER:
90190.000

APPROX. BORING B-7 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%



DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	MOISTURE CONTENT %	INSTALLATION AND COMMENTS
0.0	Medium stiff, dark brown to brown and rust-mottled, SILT with trace to some clay and trace organics; moist (FILL)	0.0		S-1	5		
2.0	Very soft, dark brown, SILT with some organics and clay; wet (NATIVE)	2.0		S-2	0	200	⊻ Groundwater level at approximately 2.0 feet bgs
5.0	becomes brown-gray, trace to some clay and trace organics	5.5		S-3	0		
	Very soft, brown, PEAT; wet						
7.0	Very soft, brown-gray, silty CLAY wIth trace organics; wet, high plasticity	7.0	ATT	S-4	0		LL = 81% PL = 35% PI = 46%
10.0	becomes some clay and trace organics			S-5	0		
15.0				S-6	0		
20.0				S-7	0		
25.0	Very soft, gray, clayey SILT to silty CLAY with trace organics; wet, high plasticity	25.0	VS	S-8			VS = 0.0 tsf
30.0				S-9	0		
35.0				S-10	0		
40.0							

DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/09/09

FIGURE A7

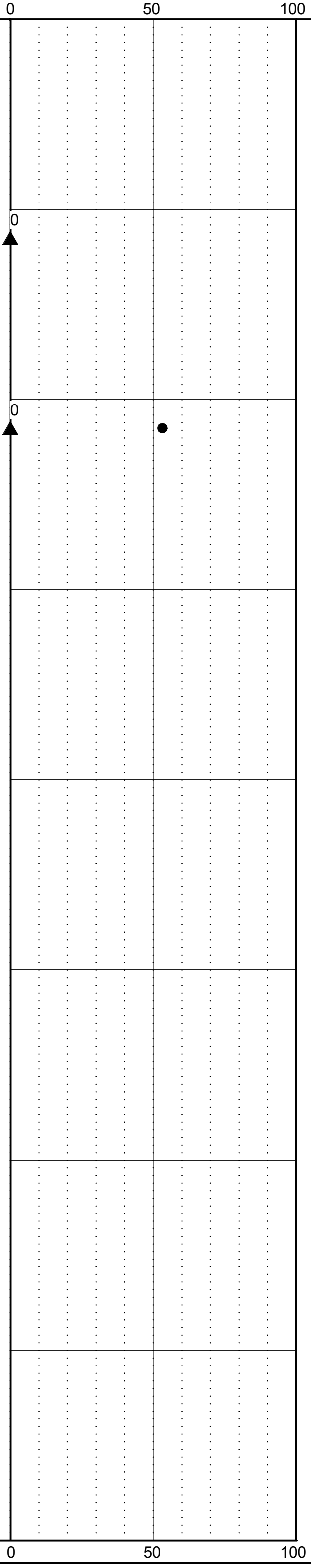
BORING B-7
(continued)

APPROX. BORING B-7 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	INSTALLATION AND COMMENTS
40.0	becomes SILT with some clay		CON VS	S-11	VS = 0.5 tsf
45.0	becomes clayey SILT to SILT with some clay			S-12	
50.0				S-13	
	Final depth 51.5 feet bgs; boring backfilled with bentonite grout and chips	51.5			
55.0					
60.0					
65.0					
70.0					
75.0					
80.0					

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/09/09

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PBS PROJECT NUMBER:
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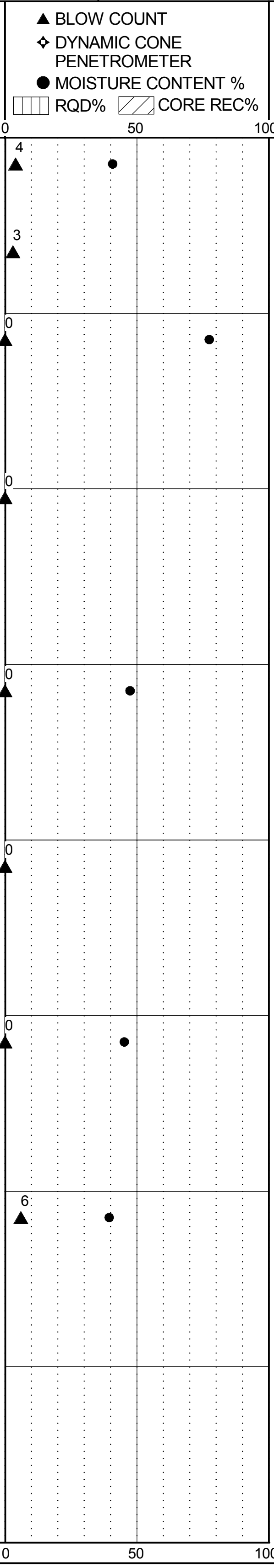
BORING B-8

APPROX. BORING B-8 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH	MATERIAL DESCRIPTION	TESTING	SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
0.0	Soft to medium stiff, brown with rust mottles, SILT with trace clay and organics; dry (FILL)		S-1	4	
	becomes gray-brown with rust mottles, some clay; moist		S-2	3	
4.5	Very soft, dark brown-gray, ORGANIC SILT to SILT with some organics; wet (NATIVE)		S-3	0	⊻ Groundwater level at approximately 4.5 feet bgs
	becomes ORGANIC SILT to SILT with trace to some organics and trace fine sand	CON	S-4		
		VS	S-5	0	VS = 0.0 tsf
15.0	Very soft, dark gray, fine sandy SILT with trace organics and shell fragments; wet, high plasticity		S-6	0	
18.0	Very soft, gray, SILT with trace to some sand, trace organics and shell fragments; wet, high plasticity		S-7	0	
		P200	S-8	0	P200 = 64%
	becomes medium stiff		S-9	6	
31.5	Final depth 31.5 feet bgs; backfilled with bentonite grout and chips				



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/09/09

FIGURE A8

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CHINA CAMP CREEK
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BORING B-9

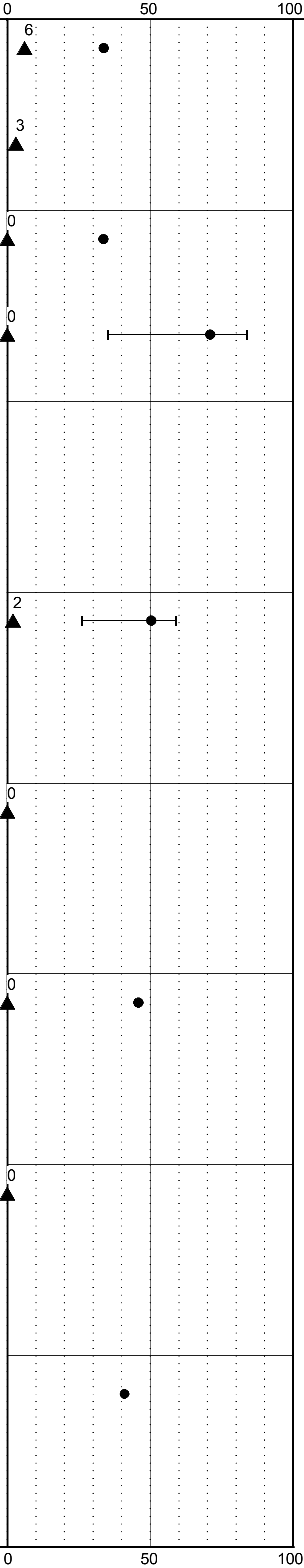
PBS PROJECT NUMBER:
90190.000

APPROX. BORING B-9 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%

DEPTH	MATERIAL DESCRIPTION	TESTING	SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
0.0	Medium stiff, light brown, SILT with trace fine to medium sand and trace clay; dry to moist (FILL)		S-1	6	
2.0	Soft, tan mottled rust, clayey SILT to SILT with some clay; moist		S-2	3	
4.5	Very soft, tan with rust mottles, SILT with trace to some clay and trace organics; moist; interlayered with very loose, light brown, fine to medium SAND with some silt; dry to moist		S-3	0	
7.0	Very soft, dark brown, ORGANIC CLAY; wet, grading within sample to very soft, gray silty CLAY with trace organics; wet, high plasticity (NATIVE)	ATT	S-4	0	⊻ Groundwater level at 7.5 feet bgs (inferred from samples) LL = 84% PL = 35% PI = 49%
8.5	Very soft, gray, clayey SILT with trace organics; wet, high plasticity				
9.5	Soft, gray, SILT with sand; wet, high plasticity		S-5		
13.0	Very soft, gray, CLAY with some silt and trace organics; wet, high plasticity				
15.8	Very soft, gray, fine SILT with trace fine sand and organics; wet, high plasticity	ATT	S-6	2	LL = 59% PL = 26% PI = 33%
			S-7	0	
			S-8	0	
			S-9	0	
33.0	Loose to medium dense, gray, silty fine SAND with trace organics; wet, high plasticity fines	P200	S-10		P200 = 48%



DEPTH FEET: 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0

DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/09/11

FIGURE A9

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CHINA CAMP CREEK
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PBS PROJECT NUMBER:
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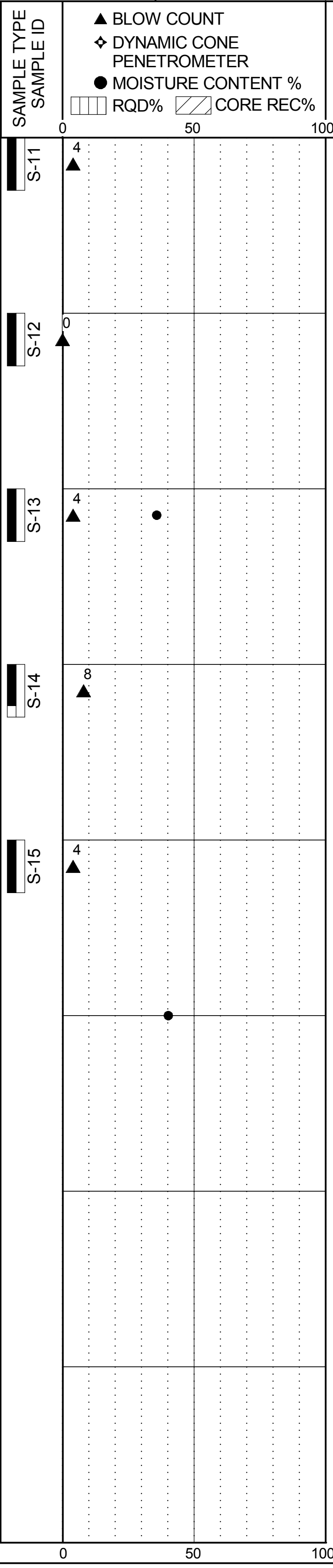
BORING B-9
(continued)

APPROX. BORING B-9 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH
40.0 – 43.0		
43.0 – 48.0	Very soft, brown-gray, SILT with trace fine sand, clay, and organics; wet, high plasticity	43.0
48.0 – 61.5	Very loose to loose, gray, silty fine to medium SAND with trace to some silt, trace organics, and shell fragments; wet, high plasticity fines	48.0
61.5	Final depth 61.5 feet bgs; backfilled with bentonite grout and chips	61.5



TESTING

INSTALLATION AND COMMENTS

DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/09/11

FIGURE A9

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CHINA CAMP CREEK
COQUILLE, OREGON

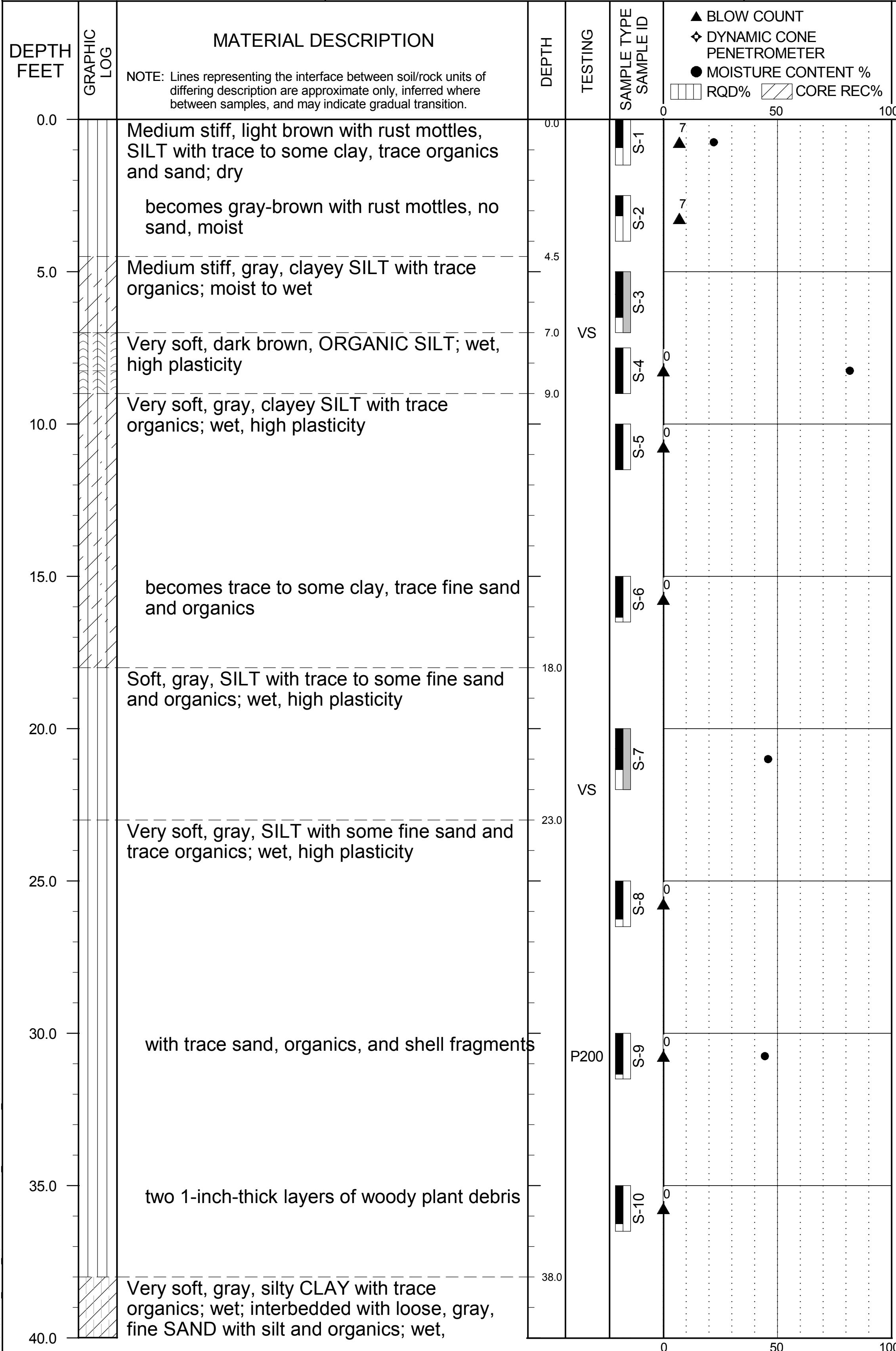
BORING B-10

PBS PROJECT NUMBER:
90190.000

APPROX. BORING B-10 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH	MATERIAL DESCRIPTION	TESTING	SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
0.0	Medium stiff, light brown with rust mottles, SILT with trace to some clay, trace organics and sand; dry		S-1	7	
	becomes gray-brown with rust mottles, no sand, moist		S-2	7	
4.5	Medium stiff, gray, clayey SILT with trace organics; moist to wet		S-3		
7.0	Very soft, dark brown, ORGANIC SILT; wet, high plasticity	VS	S-4	0	⊻ Groundwater level at 7.0 feet bgs (inferred from samples) VS = 0.75 tsf
9.0	Very soft, gray, clayey SILT with trace organics; wet, high plasticity		S-5	0	
	becomes trace to some clay, trace fine sand and organics		S-6	0	
18.0	Soft, gray, SILT with trace to some fine sand and organics; wet, high plasticity		S-7		
		VS			VS = 0.5 tsf
23.0	Very soft, gray, SILT with some fine sand and trace organics; wet, high plasticity		S-8	0	
	with trace sand, organics, and shell fragments	P200	S-9	0	P200 = 60%
	two 1-inch-thick layers of woody plant debris		S-10	0	
38.0	Very soft, gray, silty CLAY with trace organics; wet; interbedded with loose, gray, fine SAND with silt and organics; wet,				



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/10/11

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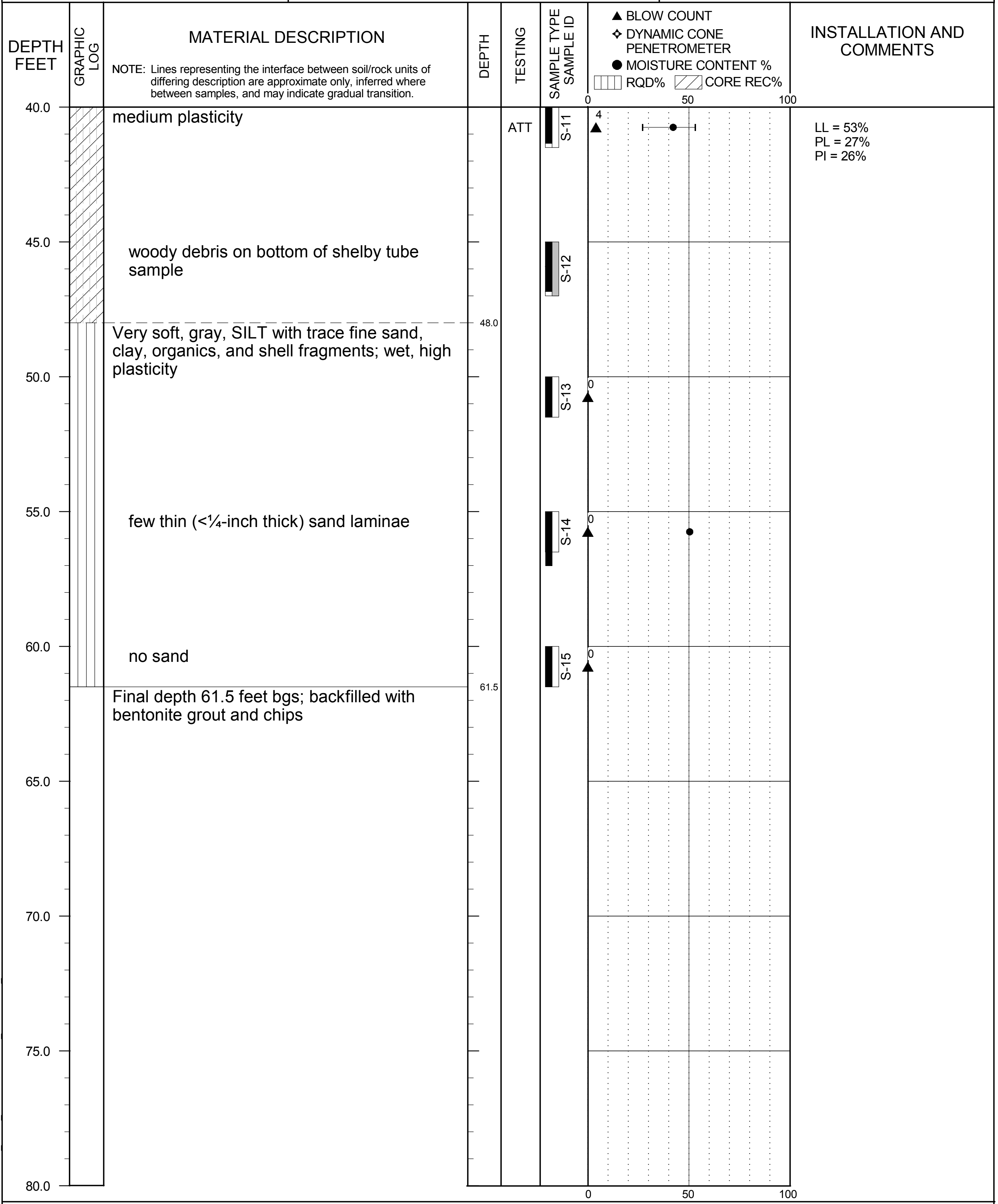
BORING B-10
(continued)

APPROX. BORING B-10 LOCATION:
(See Site Plan)



NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
40.0	medium plasticity		ATT	S-11	4	LL = 53% PL = 27% PI = 26%
45.0	woody debris on bottom of shelby tube sample			S-12		
	Very soft, gray, SILT with trace fine sand, clay, organics, and shell fragments; wet, high plasticity	48.0				
50.0				S-13	0	
55.0	few thin (<¼-inch thick) sand laminae			S-14	0	
60.0	no sand			S-15	0	
	Final depth 61.5 feet bgs; backfilled with bentonite grout and chips	61.5				
65.0						
70.0						
75.0						
80.0						

DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/10/11

FIGURE A10

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PBS PROJECT NUMBER:
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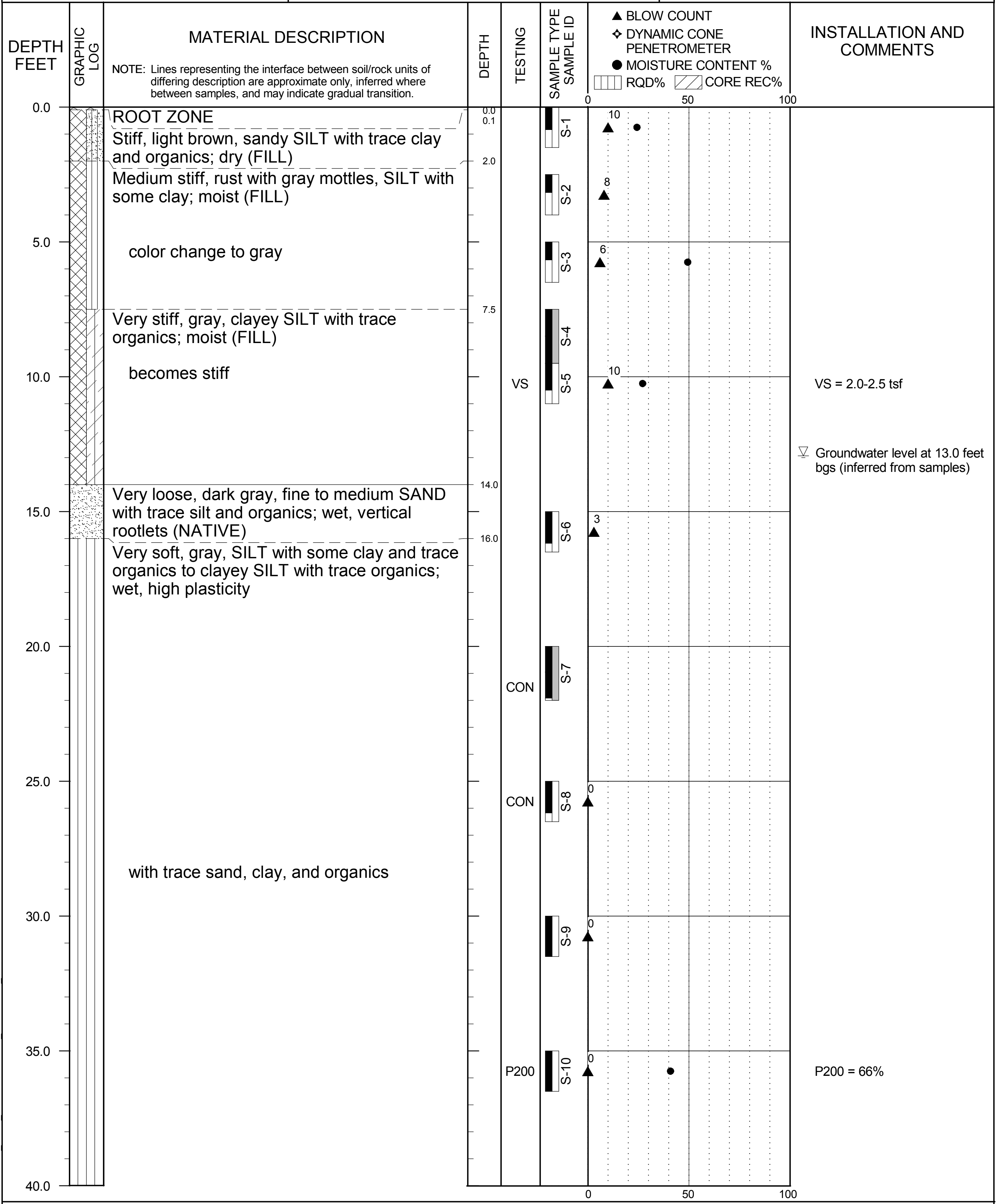
BORING B-11

APPROX. BORING B-11 LOCATION:
(See Site Plan)



NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
0.0	ROOT ZONE	0.0				
	Stiff, light brown, sandy SILT with trace clay and organics; dry (FILL)	0.1		S-1	10	
	Medium stiff, rust with gray mottles, SILT with some clay; moist (FILL)	2.0		S-2	8	
5.0	color change to gray			S-3	6	
	Very stiff, gray, clayey SILT with trace organics; moist (FILL)	7.5		S-4		
10.0	becomes stiff		VS	S-5	10	VS = 2.0-2.5 tsf
						⊻ Groundwater level at 13.0 feet bgs (inferred from samples)
	Very loose, dark gray, fine to medium SAND with trace silt and organics; wet, vertical rootlets (NATIVE)	14.0				
15.0				S-6	3	
	Very soft, gray, SILT with some clay and trace organics to clayey SILT with trace organics; wet, high plasticity	16.0				
20.0			CON	S-7		
25.0			CON	S-8	0	
	with trace sand, clay, and organics					
30.0				S-9	0	
35.0			P200	S-10	0	P200 = 66%
40.0						

DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/11/11

FIGURE A11

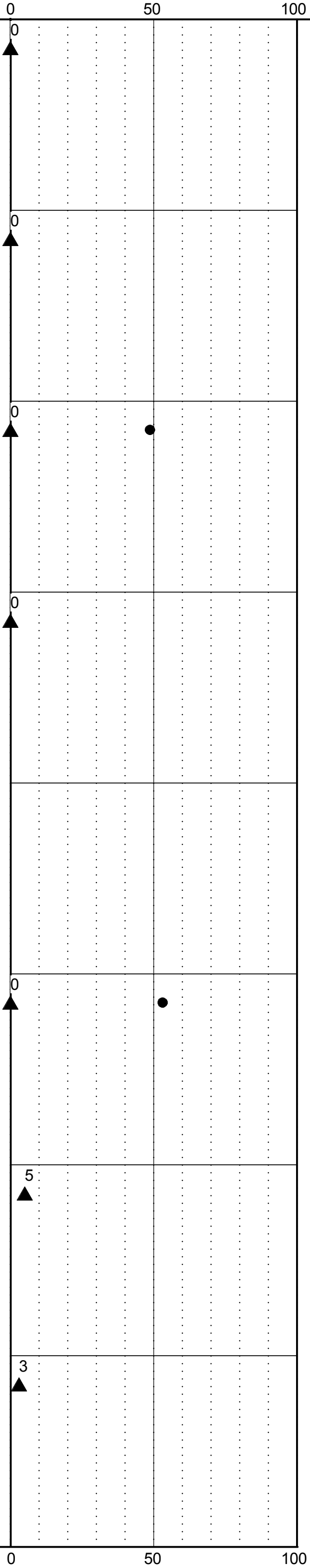
BORING B-11
(continued)

APPROX. BORING B-11 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD% ▨ CORE REC%

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
40.0	with some fine sand, trace clay and organics			S-11	0	
45.0	Very soft, gray, SILT with trace sand and organics; wet, high plasticity	45.0		S-12	0	
	with trace to some sand and trace organics and shell fragments					
50.0				S-13	0	
55.0				S-14	0	
	Very soft to soft, gray, SILT with trace to some fine sand and trace organics; wet, high plasticity	57.0				
60.0			VS	S-15		VS = 0.75 tsf
	Very soft to soft, gray, SILT with some organics, trace clay and fine sand; wet, high plasticity	63.0				
65.0				S-16	0	
	Medium stiff, gray, SILT with trace clay, sand, and organics; wet; interlaminated with loose, gray, fine to medium SAND with trace silt, organics, and shell fragments; wet, high plasticity	69.0				
70.0				S-17	5	
	Very soft, gray, SILT with trace to some sand and trace organics, shell fragments; wet, high plasticity	73.0				
75.0				S-19	3	
	Medium stiff, gray, SILT with trace to some clay and organics; wet; interbedded with loose, gray, fine to medium SAND with trace	78.0				
80.0						



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/11/11

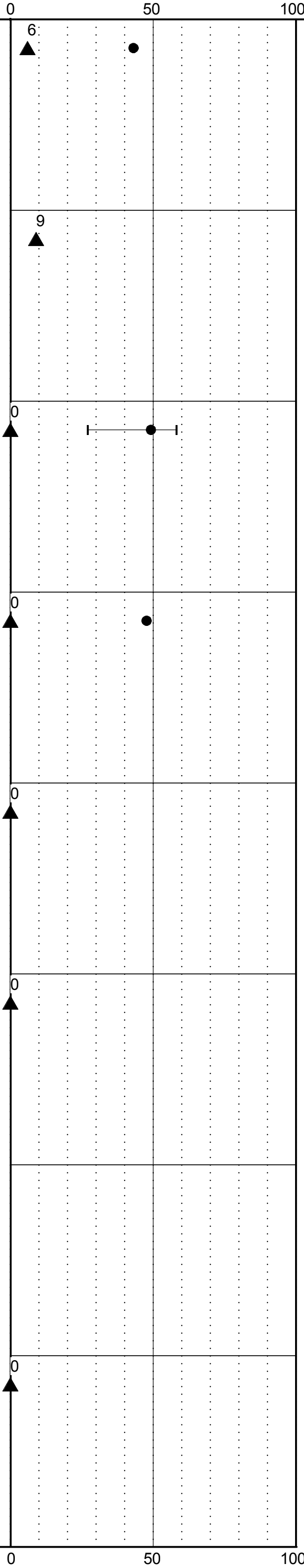
BORING B-11
(continued)

APPROX. BORING B-11 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

▲ BLOW COUNT
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
80.0	silt, organics, and shell fragments; wet, high plasticity			S-19	6	
	Medium dense, gray, silty fine to coarse SAND with trace organics; wet, high plasticity fines	83.0				
85.0				S-20	9	
	Medium stiff, gray, clayey SILT with trace organics; wet, high plasticity	86.0				
	Very soft, brown-gray, SILT with trace to some clay and trace organics; wet, high plasticity	88.0				
90.0			ATT	S-21	0	LL = 58% PL = 27% PI = 31%
95.0	trace to some clay, trace fine sand and organics			S-22	0	
100.0	color change to gray, becomes some clay and trace organics; moist			S-23	0	
105.0	thin (approximately 1/8-inch thick) layers of plant debris; wet			S-24	0	
110.0	becomes soft		VS	S-25		VS = 0.75 tsf
115.0	trace sand, organics, and shell fragments			S-26	0	
120.0						



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

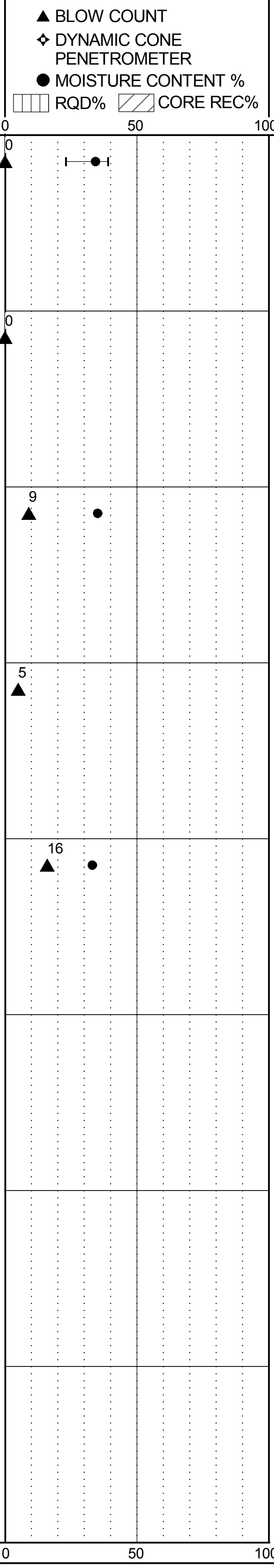
BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/11/11

BORING B-11
(continued)

APPROX. BORING B-11 LOCATION:
(See Site Plan)

NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
120.0	Soft, gray, clayey SILT with trace fine sand and organics; moist to wet, high plasticity	120.0	ATT	S-27	0	LL = 39% PL = 23% PI = 16%
125.0	becomes trace to some fine sand			S-28	0	
	Loose, gray, fine SAND with trace silt, organics, and shell fragments; moist	128.0				
130.0				S-29	9	
	Medium stiff, gray, SILT with trace to some fine sand and organics, trace clay; moist, contains numerous thin laminae of fine sand and a single pebble approximately 1¼-inch diameter at 136.0 feet bgs	133.0				
135.0				S-30	5	
	Medium dense, gray, fine to medium SAND with some organics and trace silt; moist	138.0				
140.0						
	Very stiff, gray, silty CLAY; moist	140.8		S-31	16	
	Final depth 141.5 feet bgs; backfilled with bentonite grout and chips	141.5				
145.0						
150.0						
155.0						
160.0						



DRILLING METHOD: Mud Rotary
DRILLED BY: Hardcore Drilling
LOGGED BY: B. Portwood

BIT DIAMETER: 4 7/8-inch
HAMMER EFFICIENCY PERCENT:
LOGGING COMPLETED: 11/11/11

FIGURE A11

APPENDIX B

Laboratory Tests

APPENDIX B – LABORATORY TESTS

B1.0 GENERAL

The samples that were obtained during the field explorations were examined in the PBS laboratory. The physical characteristics of the samples were noted and the field classifications were modified where necessary. During the course of examination, representative samples were selected for further testing. The laboratory testing program adopted for this investigation included a variety of tests to provide data for the various engineering studies. The testing program on the soil samples included standard classification tests, which consisted of visual examination, moisture contents, and grain-size analyses. The classification tests yield certain index properties of the soils important to an evaluation of soil behavior. The testing procedures and results of the tests are presented in the following paragraphs. Unless noted otherwise, all test procedures followed applicable ASTM standards.

B2.0 CLASSIFICATION TESTS

B2.1 Visual Classification

The soils were classified in accordance with the Unified Soil Classification System with certain other terminology, such as the relative density or consistency of the soil deposits, in general accordance with engineering practice. In determining the soil type (i.e., gravel, sand, silt, or clay) the term which best described the major portion of the sample was used. Modifying terminology to further describe the samples is defined in Terminology Used to Describe Soil in Appendix A.

B2.2 Moisture (Water) Contents

Natural moisture content determinations were made on all samples of the fine-grained soils (i.e., silts, clays, and silty sands). The natural moisture content is defined as the ratio of the weight of water to dry weight of soil, expressed as a percentage. The results of the moisture content determinations are presented on the logs of the borings in Appendix A.

B2.3 Atterberg Limits

Atterberg limits were determined on selected samples for the purpose of classifying soils into various groups for correlation. The results of the Atterberg limits tests, which included liquid and plastic limits, are plotted on the Plasticity Chart, Figure B1, and on the logs of the borings in Appendix A.

B2.4 Grain-Size Analyses

Three No. 200 washes (P200s) were completed on samples to determine the portion of soil samples passing the No. 200 sieve (i.e. silt and clay). The results of P200 testing are presented on the log of borings in Appendix A.

B3.0 ONE-DIMENSIONAL CONSOLIDATION TESTING

Consolidation testing was conducted to obtain quantitative data for use in evaluating settlements. The test specimen was placed in a one-dimensional consolidation test apparatus (fixed ring). Loads were applied to the specimen and the resulting change in thickness of the soil sample was monitored with time. Upon completion of primary consolidation, the next load increment was applied. Consolidation test results are presented on Figures B2 in the form of logarithm of stress versus percent strain. The resulting curve shows the percent strain that occurred in the test specimen under various magnitudes of applied constant load.

B4.0 VANE SHEAR TESTING

Vane shear tests were conducted on the relatively undisturbed soil samples collected. The purpose of the vane shear testing was to measure the undrained shear strength of the soils. The shear vane device contains a four-blade vane which is connected to a calibrated torque indicator. The vane is loaded by turning the spring-loaded torque indicator at a rate of about one rotation per minute so that the soil fails in shear in less than one minute. The peak strength before failure is then recorded. Residual shear strengths may also be recorded after failure. The peak undrained is shear strengths, reported in tons per square foot (tsf), and obtained by the vane shear tests are provided on the boring logs.

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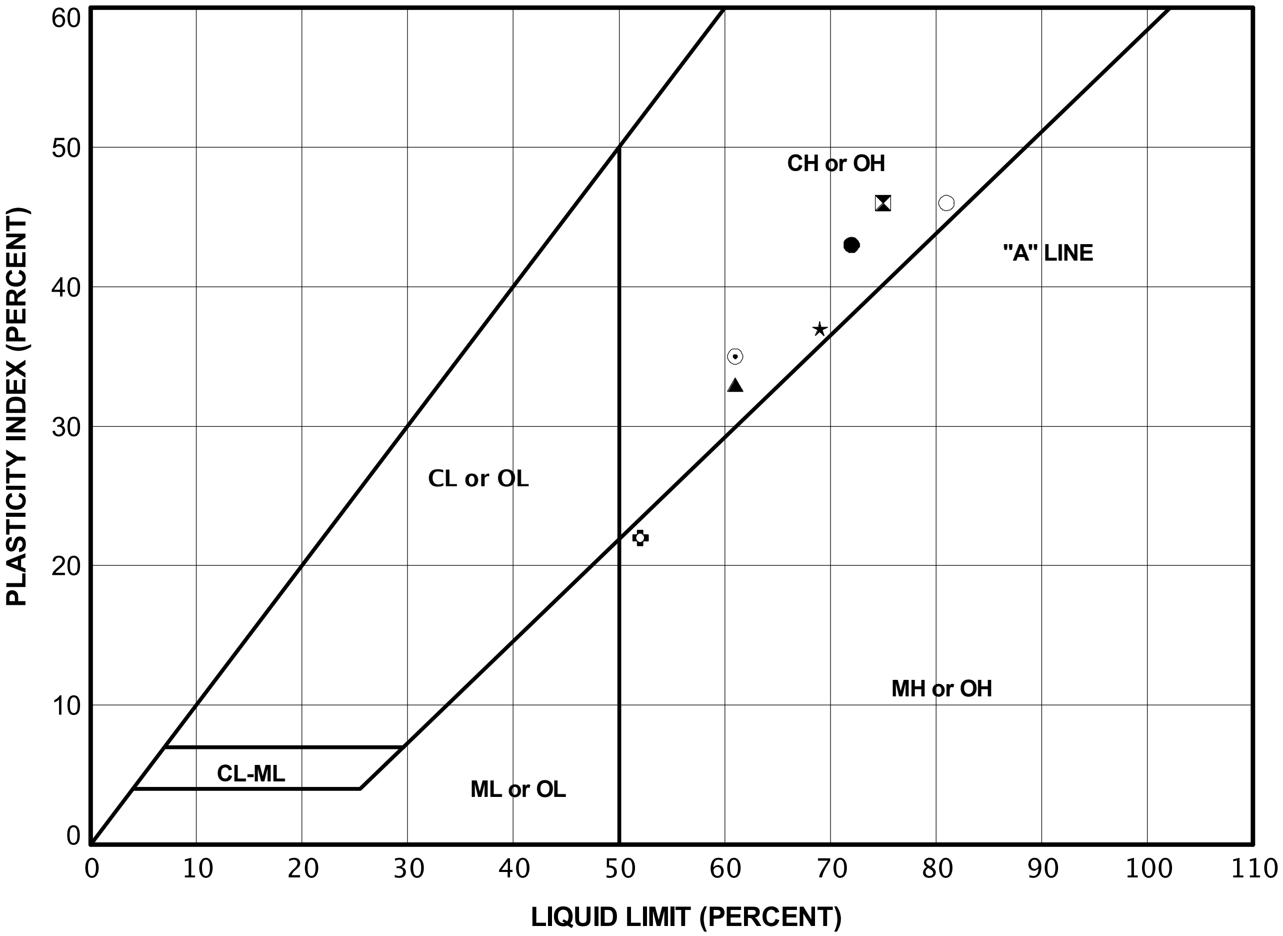
ATTERBERG LIMITS TEST RESULTS

CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

TEST METHOD: ASTM D4318



KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	NATURAL MOISTURE CONTENT (PERCENT)	PERCENT PASSING NO. 40 SIEVE (PERCENT)	LIQUID LIMIT (PERCENT)	PLASTIC LIMIT (PERCENT)	PLASTICITY INDEX (PERCENT)
●	B-1	S-3	7.0	62.2		72	29	43
⧗	B-2	S-6	15.0	69.3		75	29	46
▲	B-3	S-5	10.0	59.2		61	28	33
★	B-4	S-11	40.0	59.6		69	32	37
⊙	B-5	S-8	25.0	56.1		61	26	35
✤	B-6	S-7	20.0	53.7		52	30	22
○	B-7	S-4	7.5	80.0		81	35	46

ATTERBERG LIMITS 90190_B1-11_071213.GPJ PBS_DATATMPL_GEO.GDT PRINT DATE: 7/16/13:RSD

FIGURE B1

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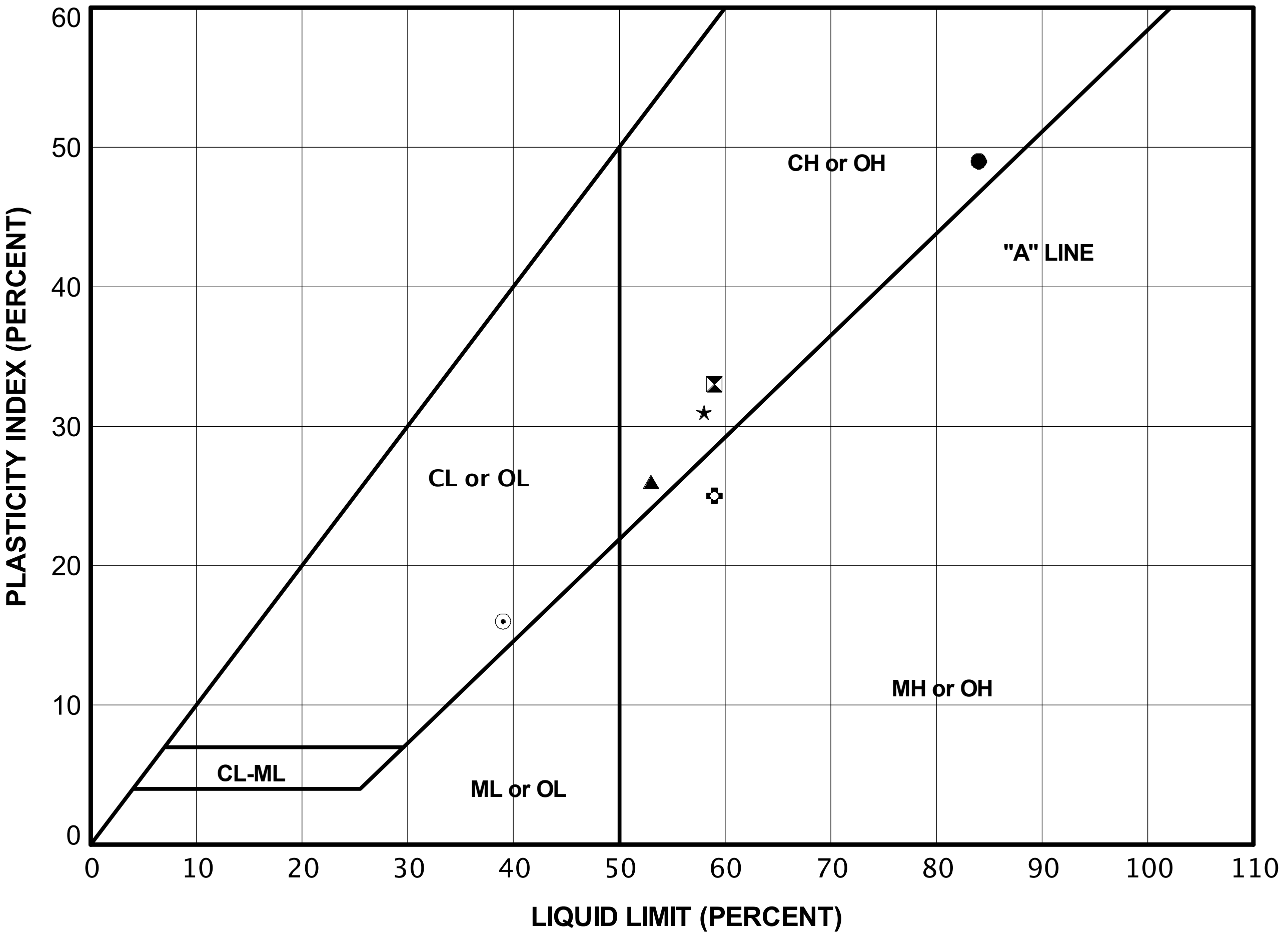
ATTERBERG LIMITS TEST RESULTS

(continued)

CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

TEST METHOD: ASTM D4318



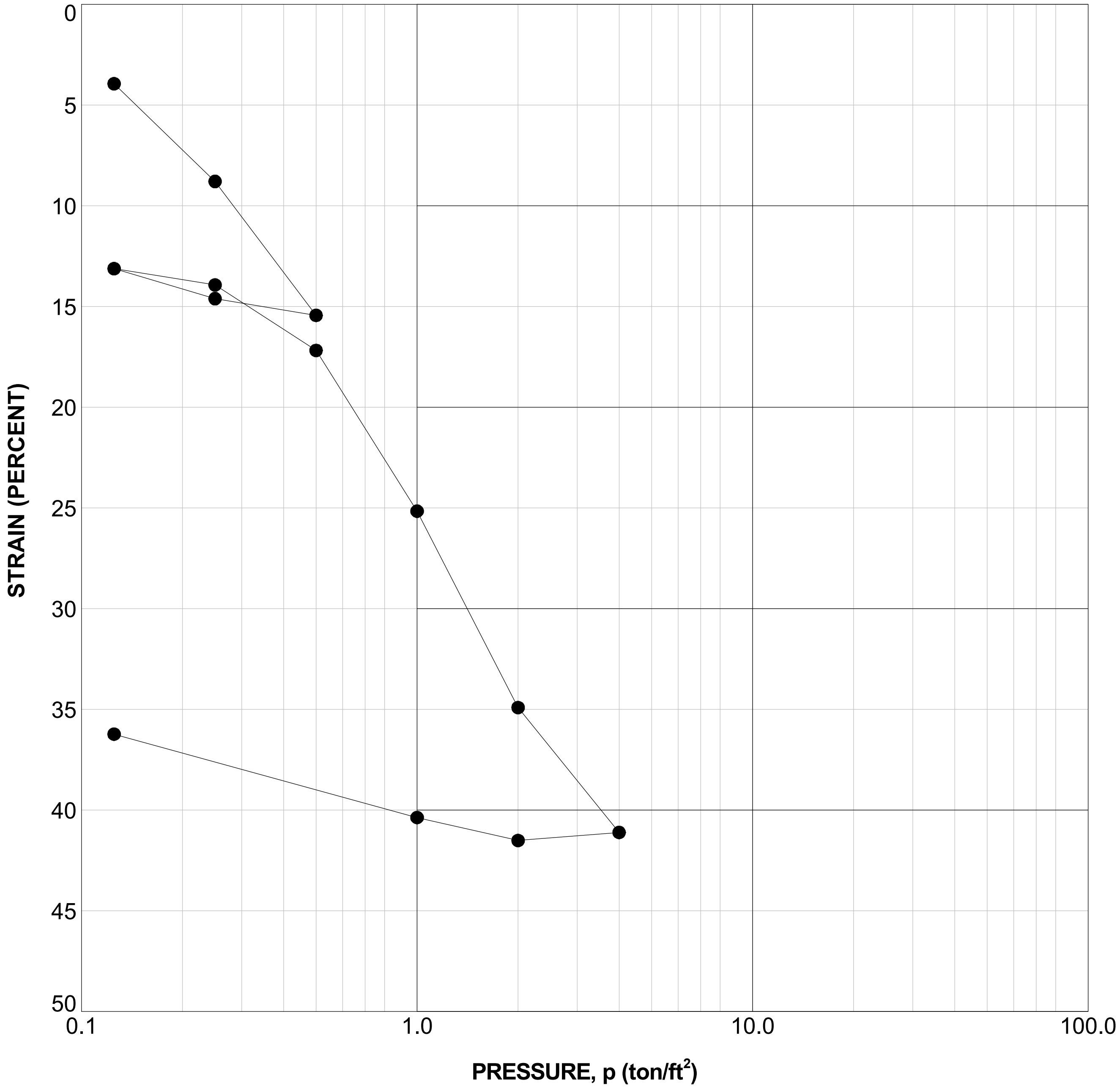
KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	NATURAL MOISTURE CONTENT (PERCENT)	PERCENT PASSING NO. 40 SIEVE (PERCENT)	LIQUID LIMIT (PERCENT)	PLASTIC LIMIT (PERCENT)	PLASTICITY INDEX (PERCENT)
●	B-9	S-4	7.5	70.9		84	35	49
⧗	B-9	S-6	15.0	50.3		59	26	33
▲	B-10	S-11	40.0	42.1		53	27	26
★	B-11	S-21	90.0	49.1		58	27	31
☉	B-11	S-27	120.0	34.2		39	23	16
✣	Borrow		1.0	19.0	82	59	34	25

FIGURE B1

CONSOLIDATION TEST RESULTS

CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000



KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-1	S-2	6.5	44.9	31.6	71.7

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CONSOLIDATION TEST RESULTS

(continued)

CHINA CAMP CREEK
COQUILLE, OREGON

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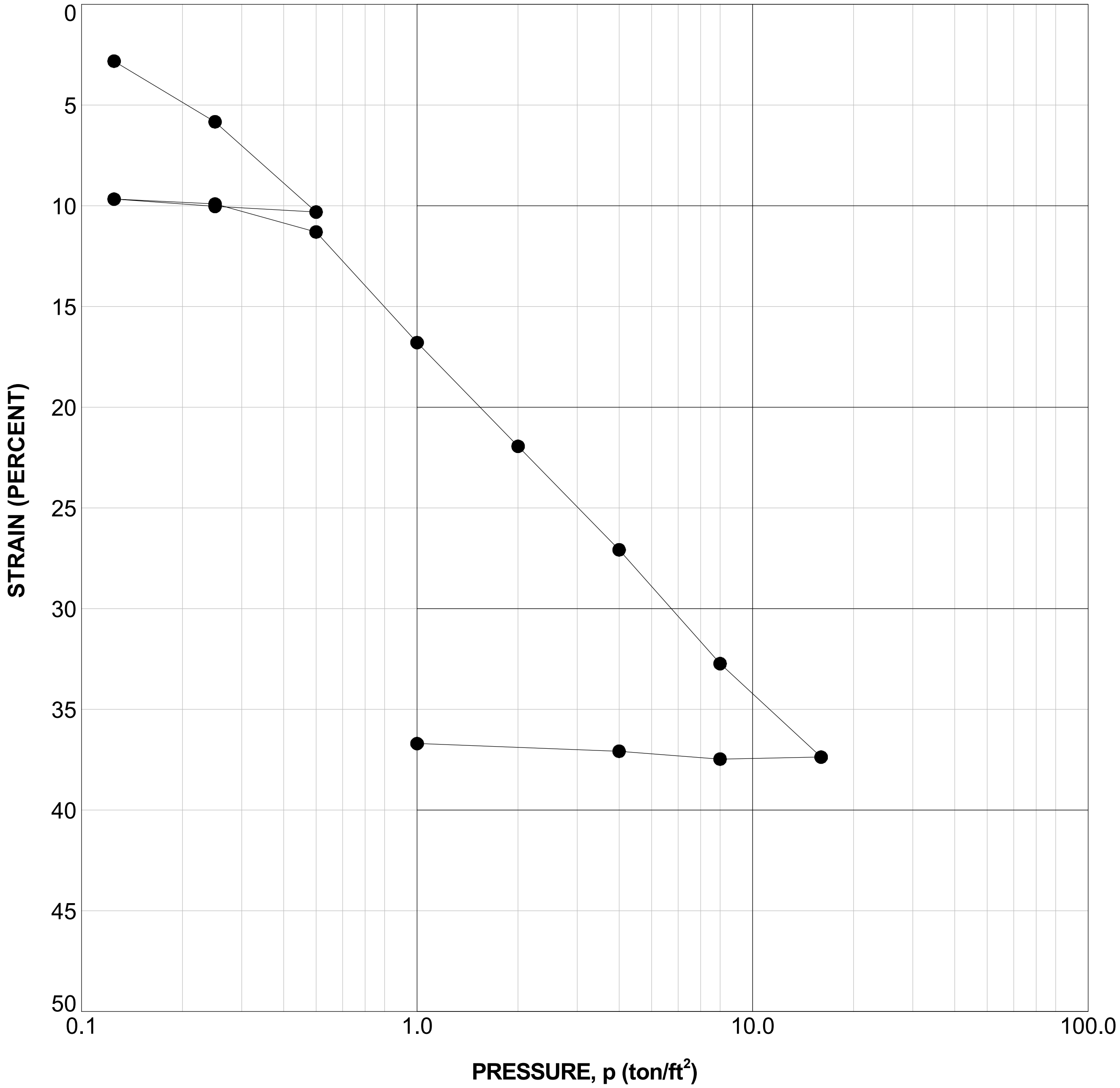
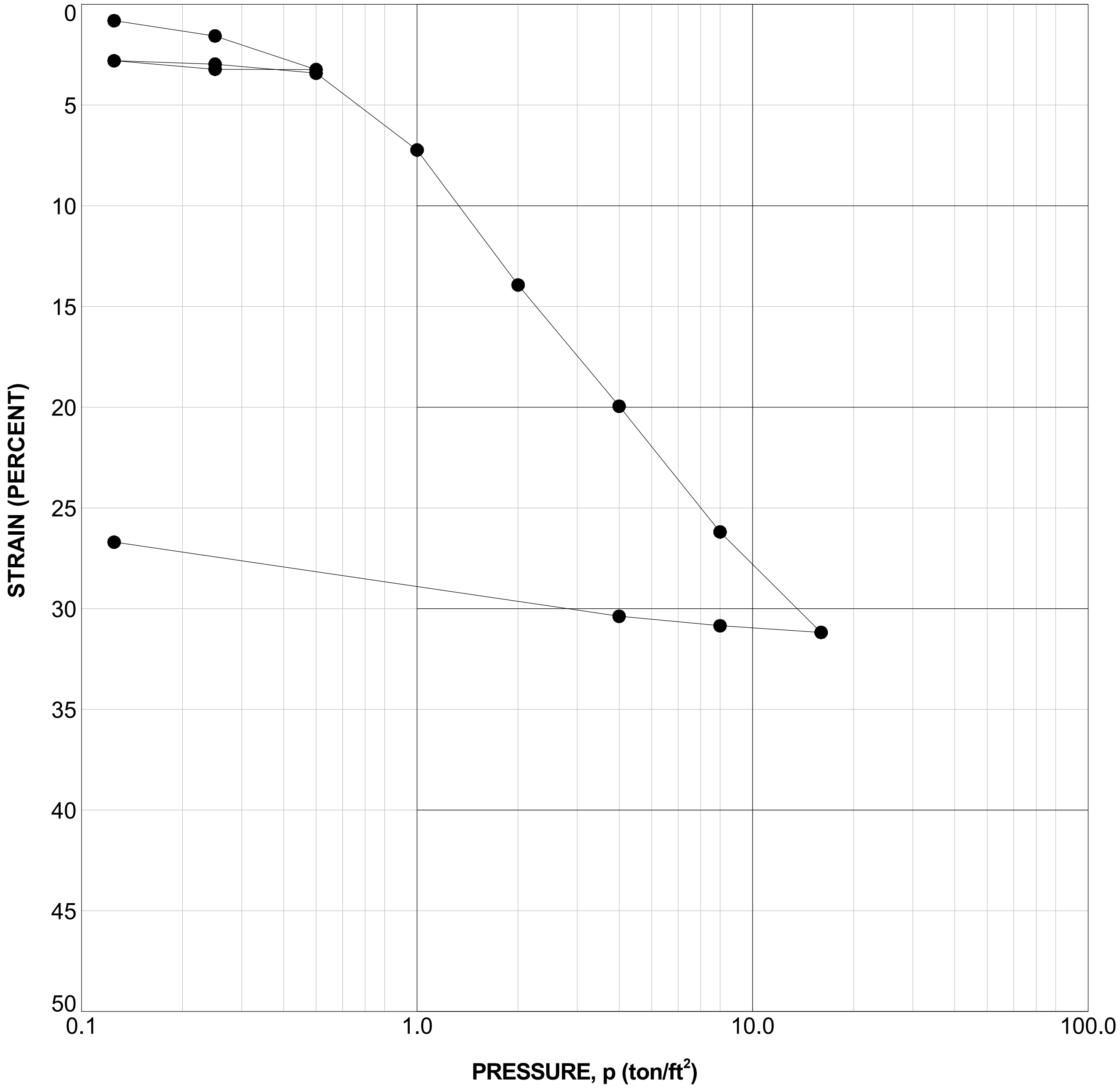
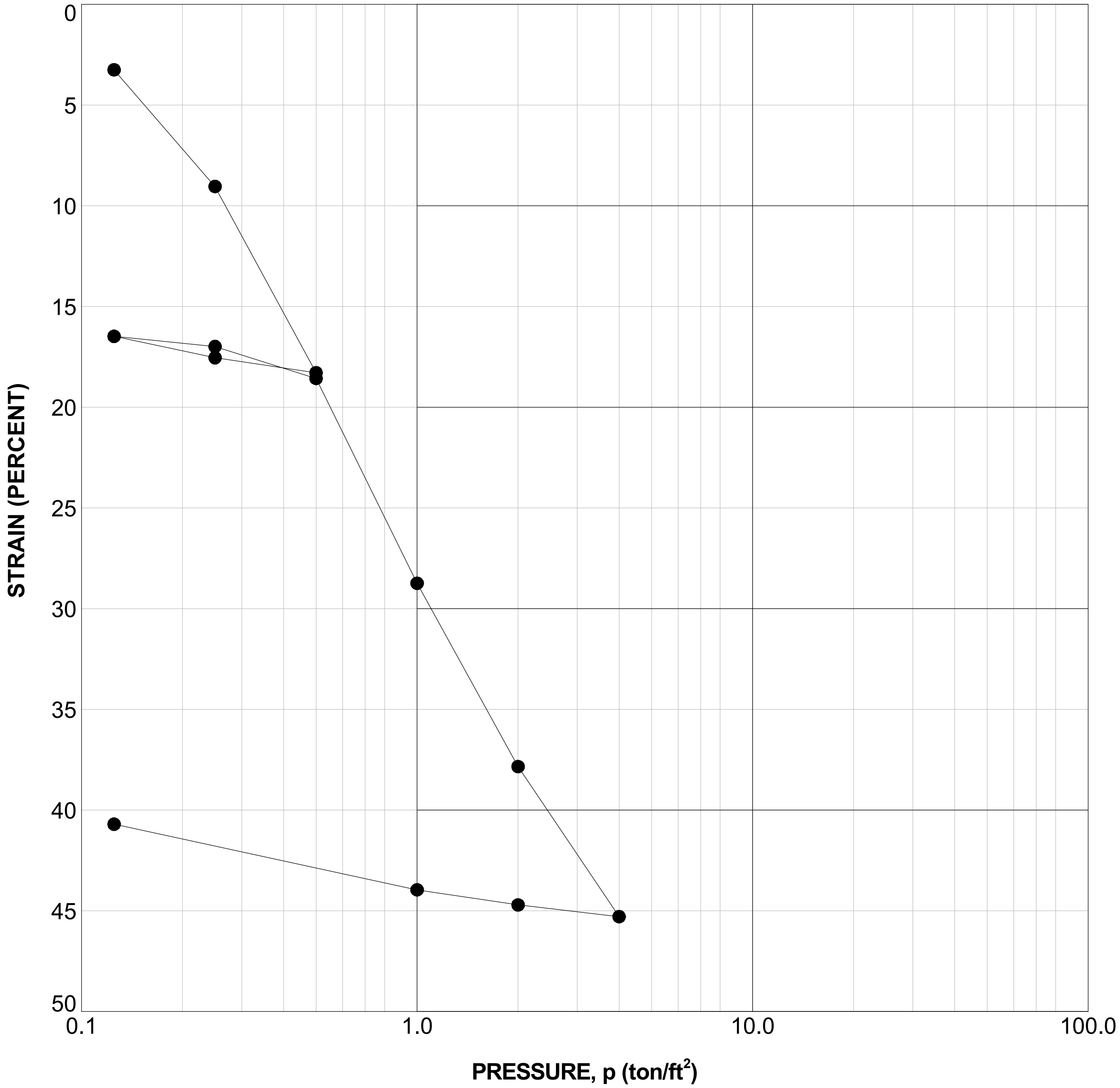


KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-2	S-4	9.0	106.5	93.6	30.9



KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-2	S-8	26.5	108.1	87.5	36.4



KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-3	S-2	3.5	95.6	49.2	85.2

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CONSOLIDATION TEST RESULTS
(continued)

CHINA CAMP CREEK
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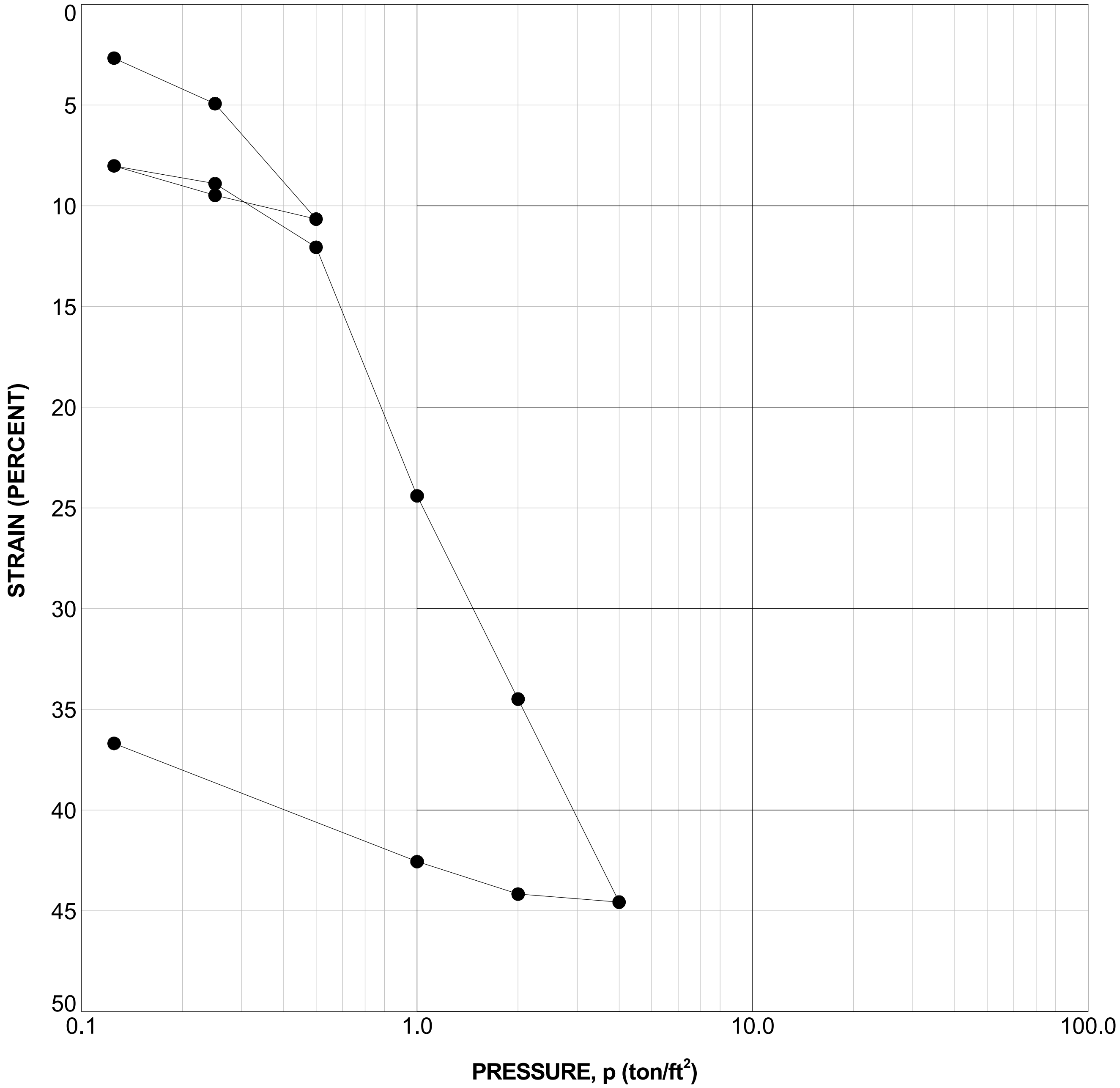

KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-4	S-4	7.5	90.8	41.1	103.6

FIGURE B2

CONSOLIDATION TEST RESULTS
(continued)

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PBS PROJECT NUMBER:
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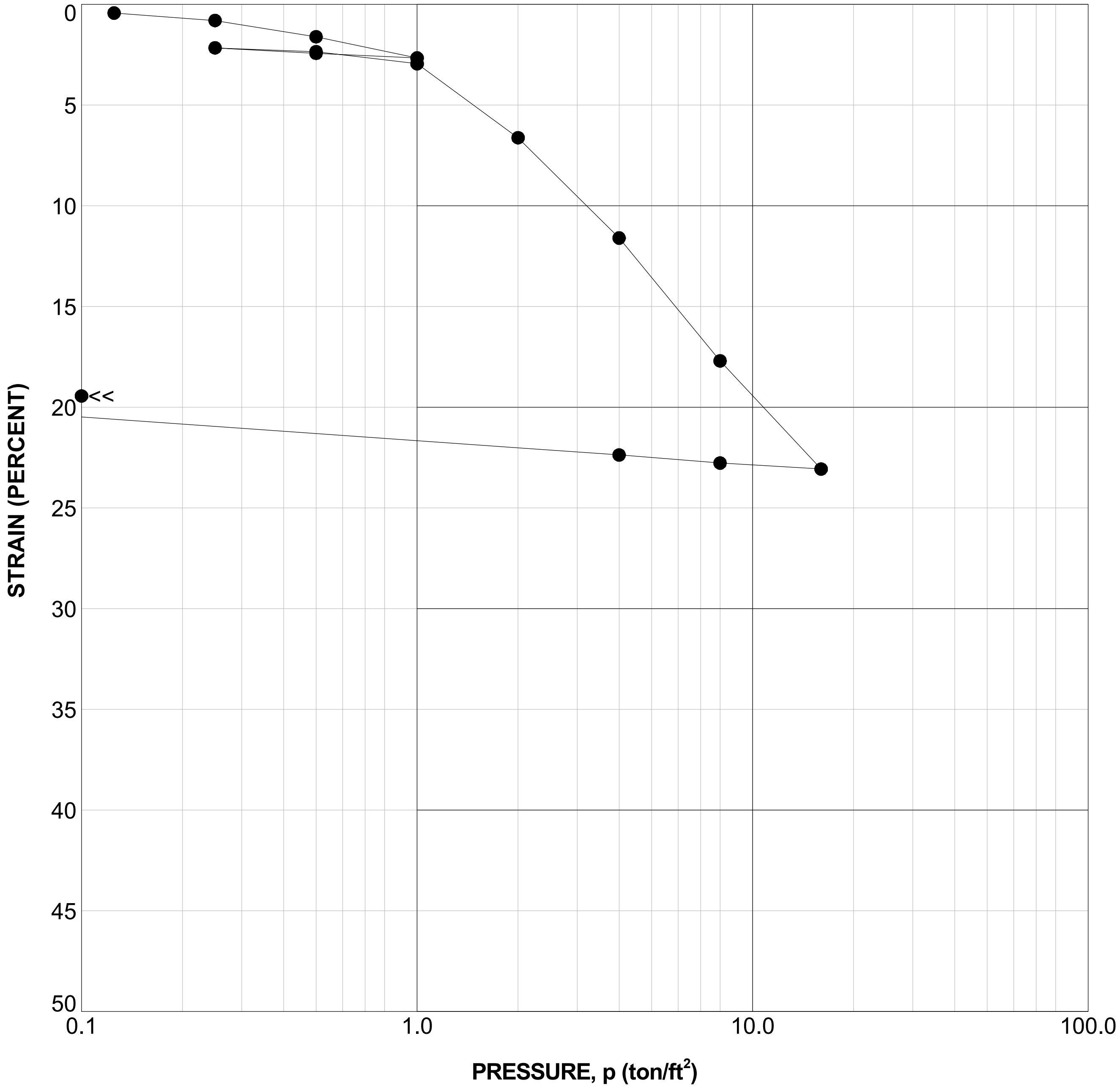

KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-4	S-13	50.0	108.0	90.6	33.7

CONSOLIDATION TEST RESULTS
(continued)

CHINA CAMP CREEK
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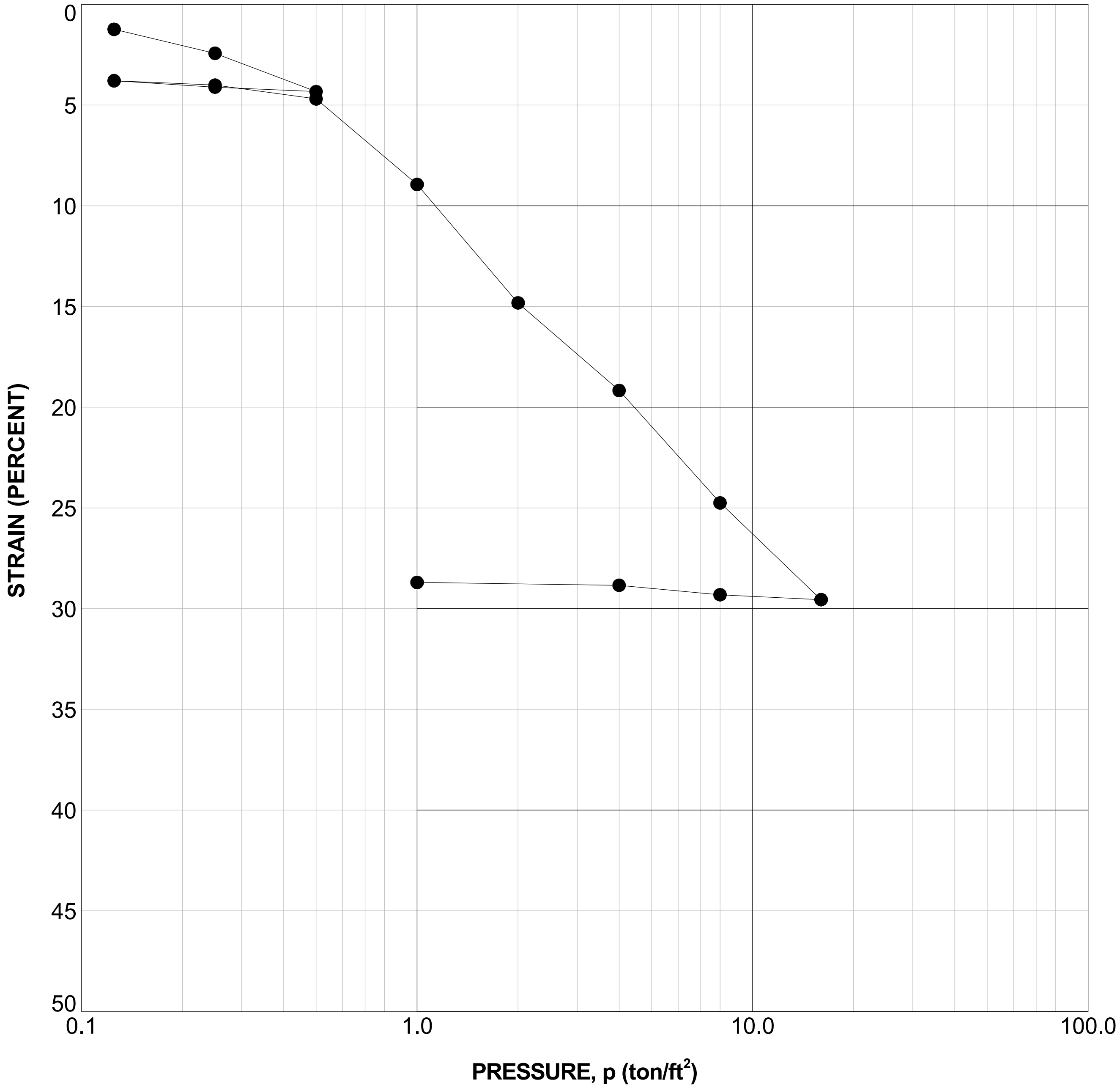
PBS PROJECT NUMBER:
90190.000



KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-5	S-6	16.5	117.6	92.6	34.9

CONSOLIDATION TEST RESULTS
(continued)

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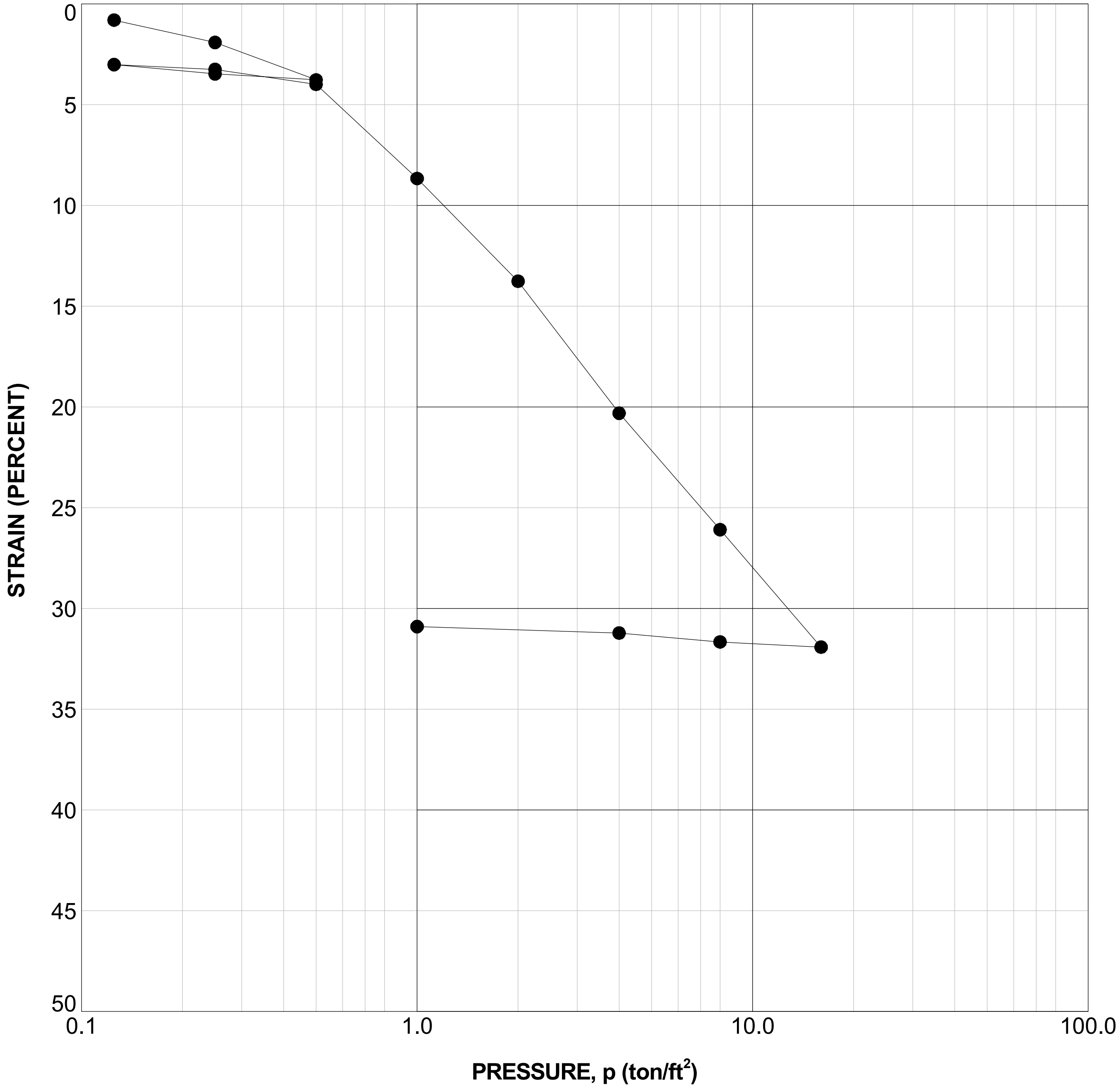

KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-6	S-5	11.5	106.5	93.4	31.6

CONSOLIDATION TEST RESULTS
(continued)

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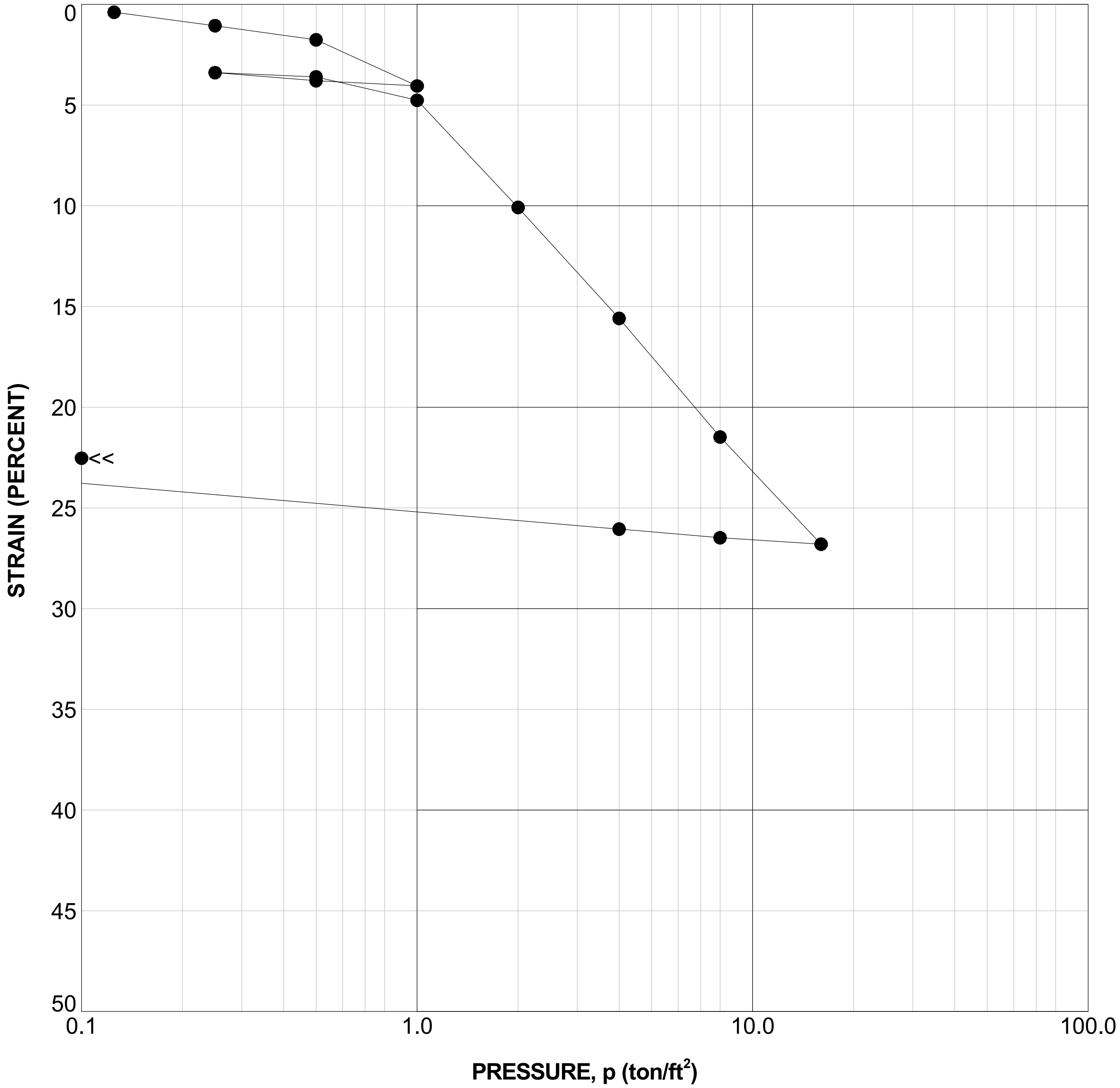

KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-7	S-11	41.0	102.8	88.3	35.3

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CONSOLIDATION TEST RESULTS
(continued)

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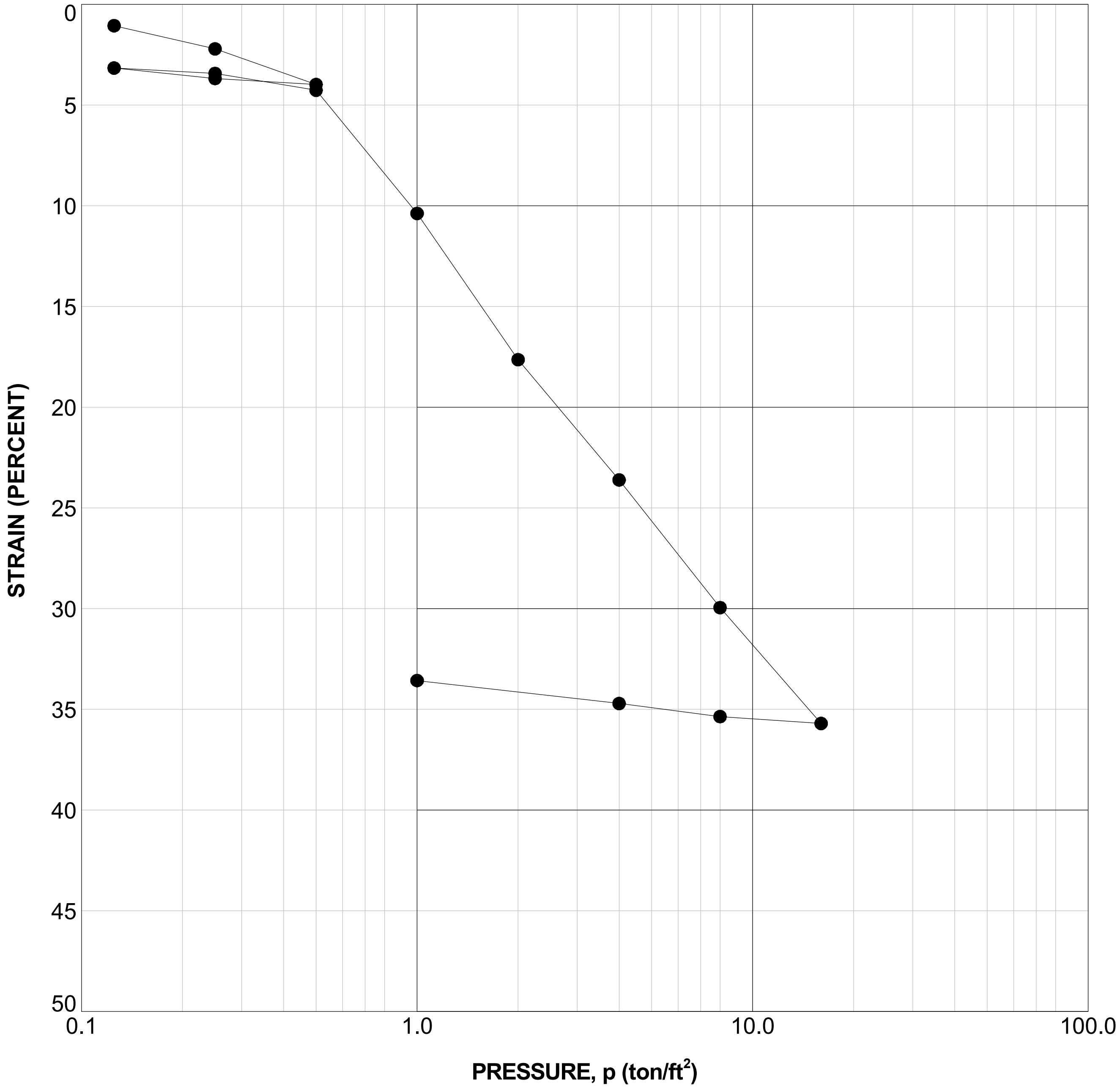

KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-8	B-8	9.0	103.3	85.3	38.0

CONSOLIDATION TEST RESULTS
(continued)

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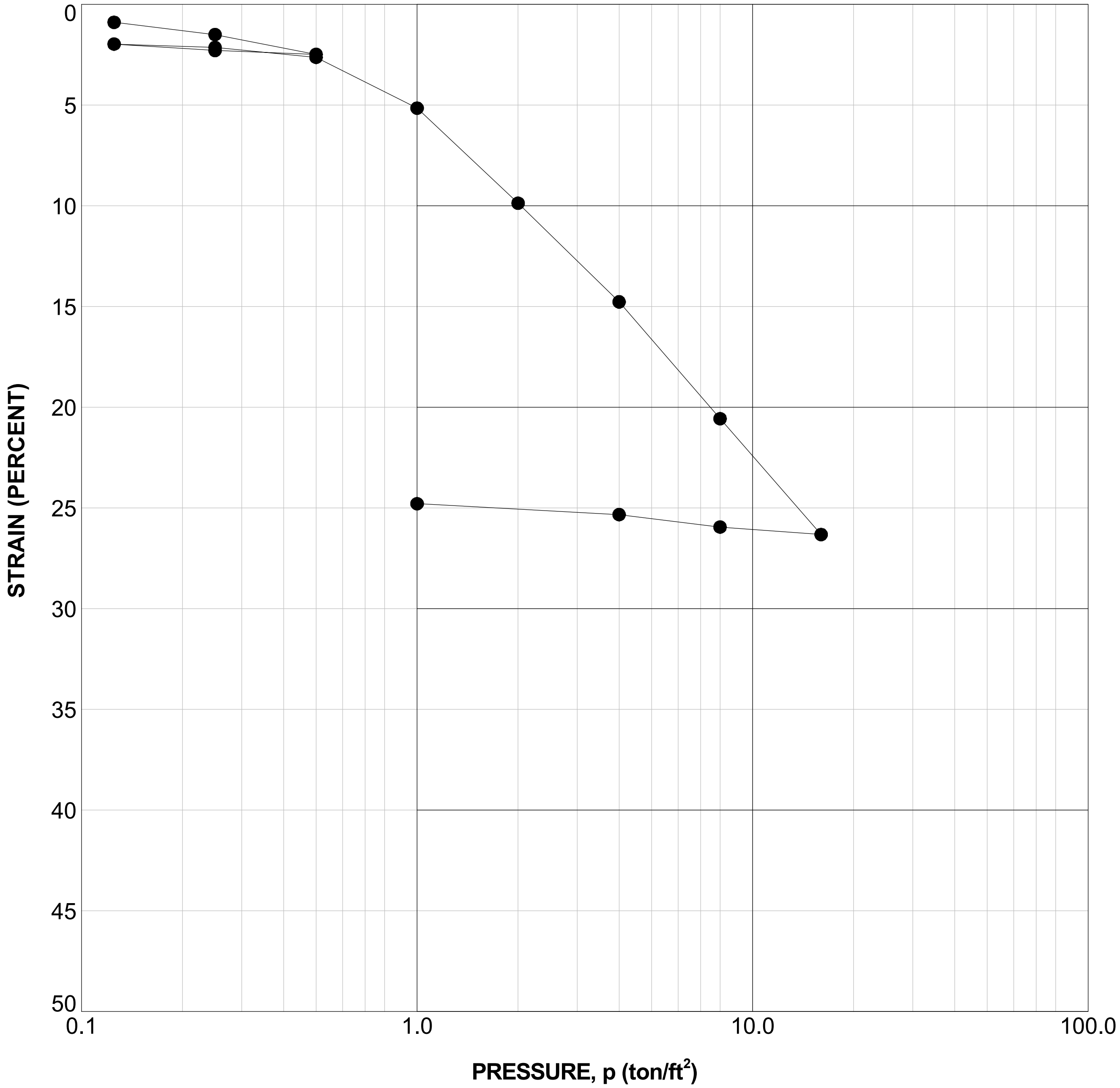

KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-11	S-7	21.5	106.1	92.8	32.8

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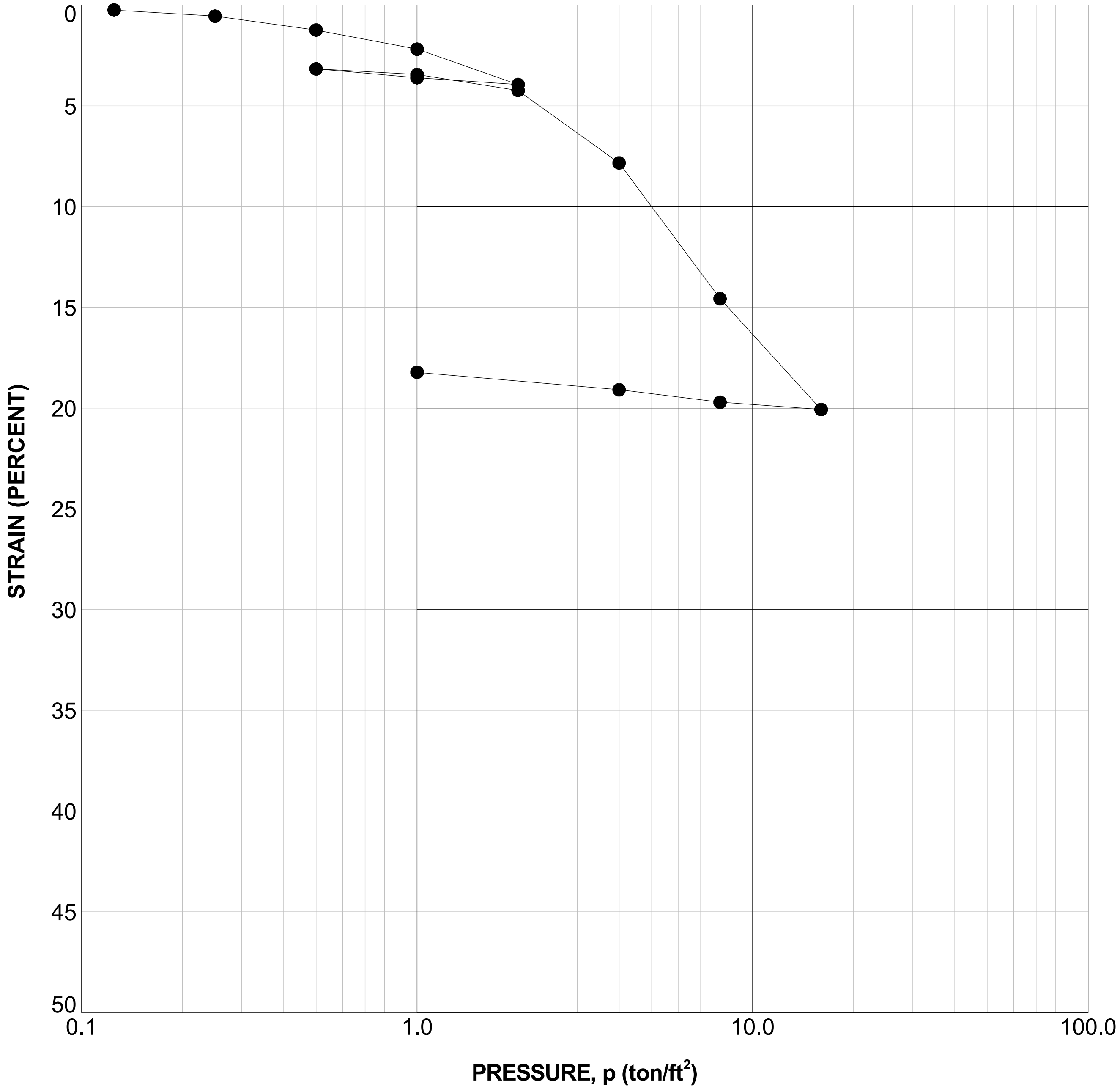

KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	INITIAL MOISTURE CONTENT (PERCENT)	INITIAL DRY DENSITY (PCF)	FINAL SATURATION (PERCENT)
●	B-11	S-25	25.0	101.4	92.2	31.8

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MOISTURE- DENSITY RELATIONSHIP

CHINA CAMP CREEK
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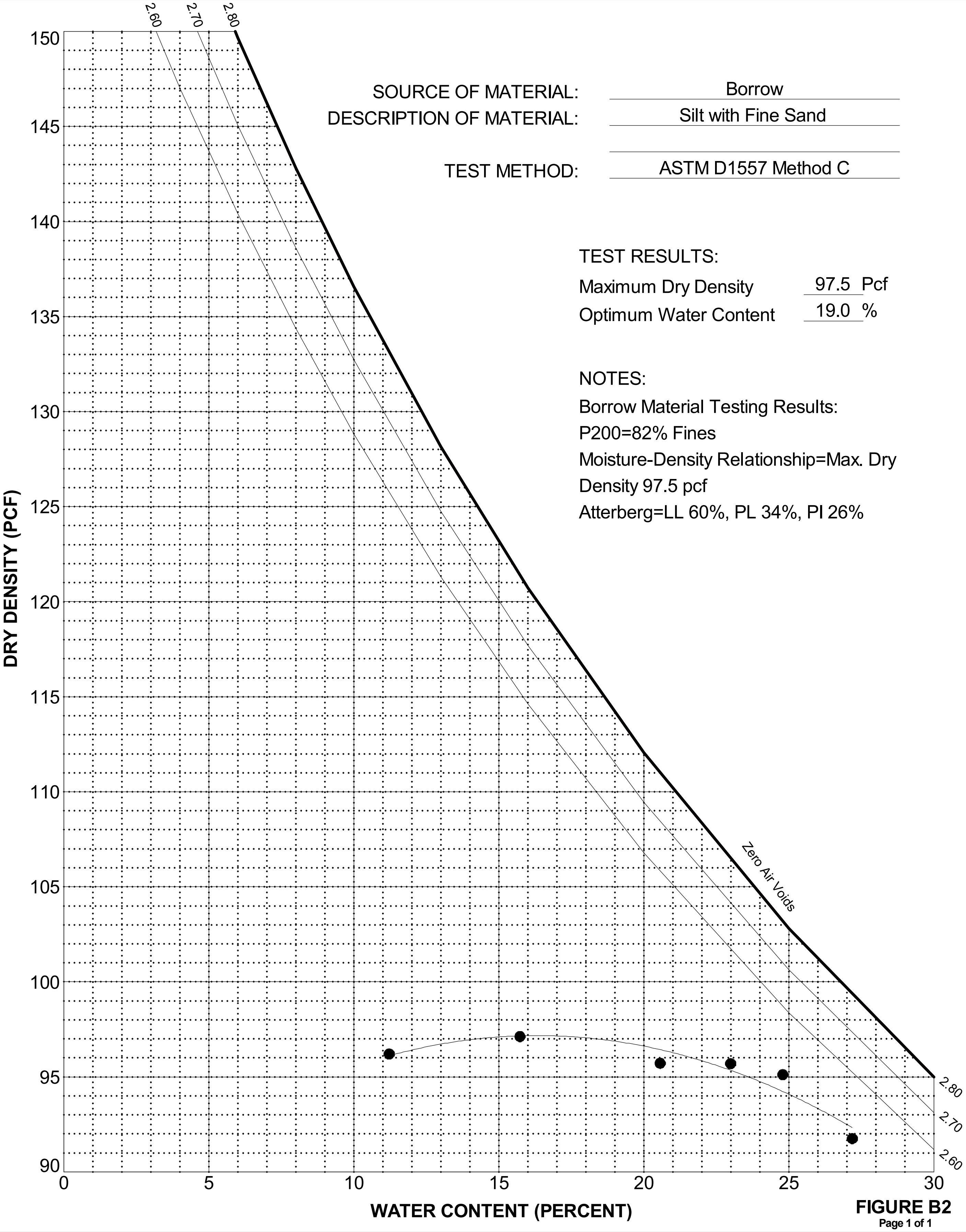

SOURCE OF MATERIAL: Borrow

DESCRIPTION OF MATERIAL: Silt with Fine Sand

TEST METHOD: ASTM D1557 Method C

TEST RESULTS:

Maximum Dry Density 97.5 Pcf

Optimum Water Content 19.0 %

NOTES:

Borrow Material Testing Results:

P200=82% Fines

Moisture-Density Relationship=Max. Dry Density 97.5 pcf

Atterberg=LL 60%, PL 34%, PI 26%

FIGURE B2

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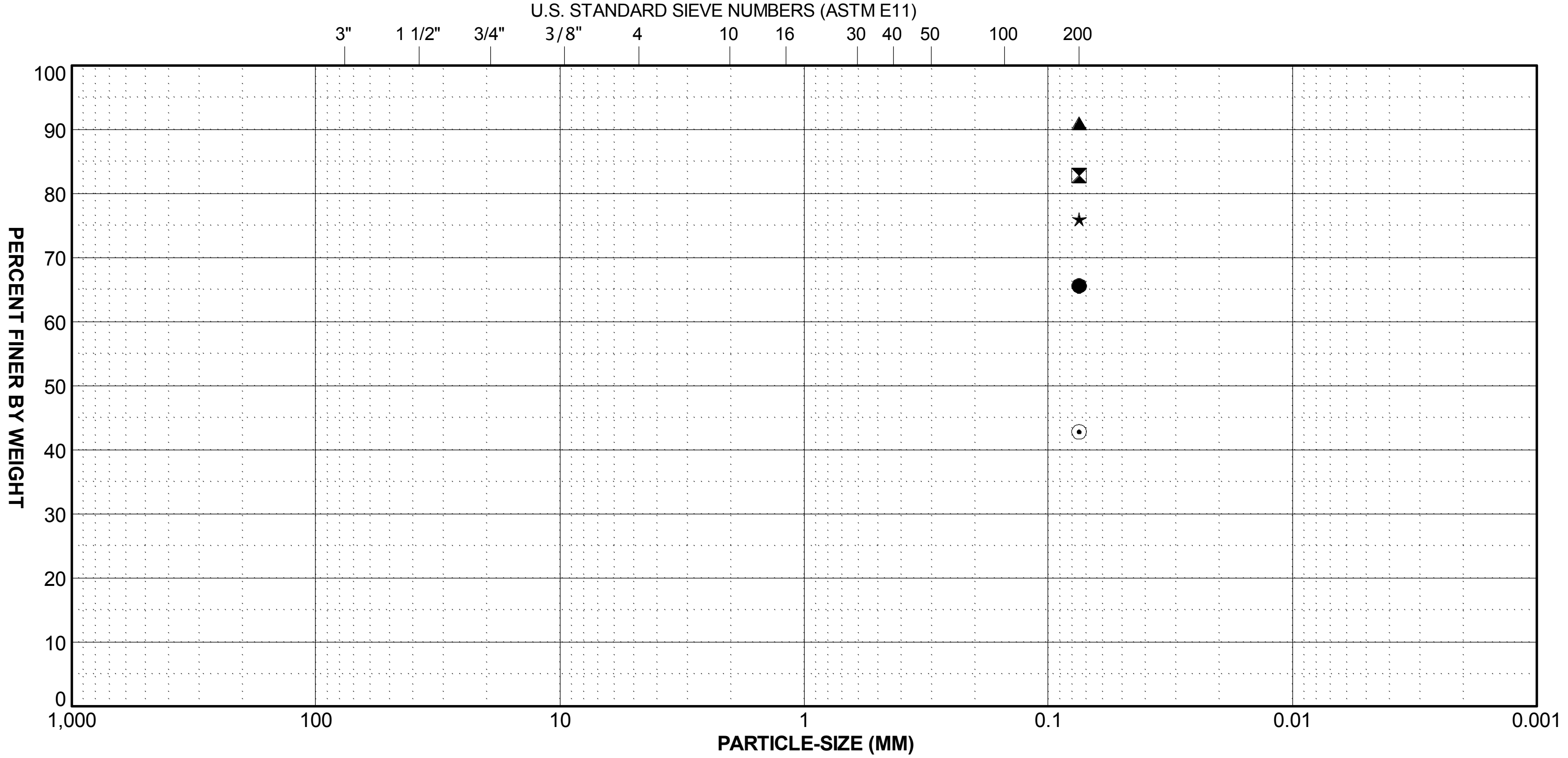
PARTICLE-SIZE ANALYSIS TEST RESULTS

CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

TEST METHOD: ASTM C136

BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY



KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	D60 (MM)	D50 (MM)	D30 (MM)	D10 (MM)	D5 (MM)	GRAVEL (PERCENT)	SAND (PERCENT)	FINES (PERCENT)
●	B-1	S-4	10.0	43								66
⧗	B-3	S-10	35.0	51								83
▲	B-4	S-6	15.0	55								91
★	B-5	S-5	10.0	47								76
⊙	B-6	S-6	15.0	60								43

FIGURE B4

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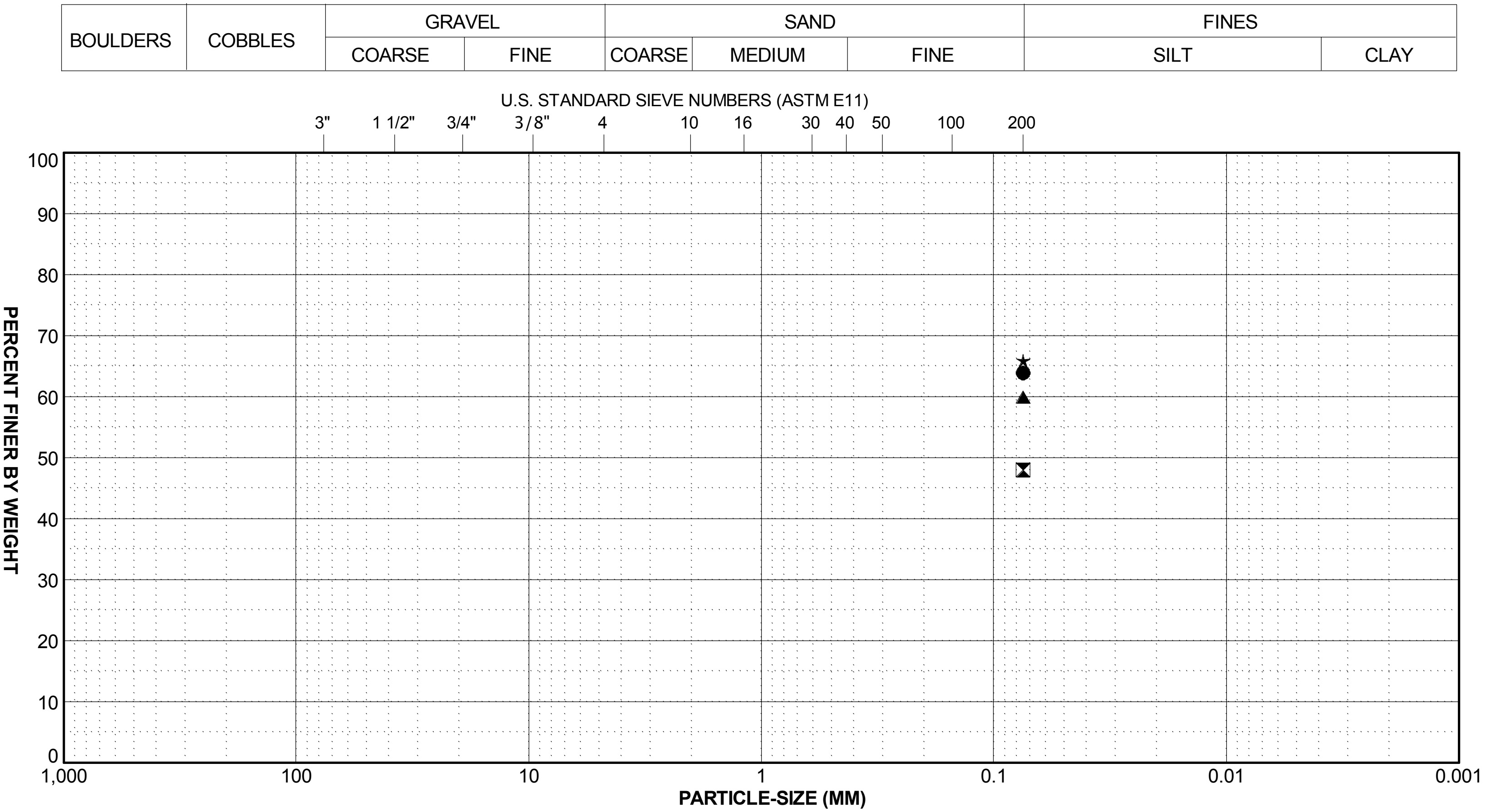
PARTICLE-SIZE ANALYSIS TEST RESULTS
(continued)

CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

TEST METHOD: ASTM C136



KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	D60 (MM)	D50 (MM)	D30 (MM)	D10 (MM)	D5 (MM)	GRAVEL (PERCENT)	SAND (PERCENT)	FINES (PERCENT)
●	B-8	S-8	25.0	45								64
⧗	B-9	S-10	35.0	41								48
▲	B-10	S-9	30.0	44								60
★	B-11	S-10	35.0	41								66

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SUMMARY OF LABORATORY DATA

CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

NOTES:

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT (PERCENT)	PLASTIC LIMIT (PERCENT)	PLASTICITY INDEX (PERCENT)
B-1	0		41							
B-1	7		62					72	29	43
B-1	10		43				66			
B-1	17.7		66							
B-1	25		61							
B-1	40		39							
B-1	55		52							
B-1	70		42							
B-1	77		66							
B-1	85		52							
B-2	0		50							
B-2	5		303							
B-2	15		69					75	29	46
B-2	30		34							
B-3	10		59					61	28	33
B-3	20		47							
B-3	35		51				83			
B-3	50		55							
B-3	65		50							
B-3	80		32							
B-4	0		43							
B-4	15		55				91			
B-4	30		57							

FIGURE B5

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SUMMARY OF LABORATORY DATA
(continued)

CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT (PERCENT)	PLASTIC LIMIT (PERCENT)	PLASTICITY INDEX (PERCENT)
B-4	40		60					69	32	37
B-4	65		37							
B-4	80		27							
B-4	95		49							
B-4	110		25							
B-4	125		30							
B-4	140		31							
B-5	0		48							
B-5	7.5		54							
B-5	10		47				76			
B-5	25		56					61	26	35
B-6	0		24							
B-6	5		81							
B-6	15		60				43			
B-6	20		54					52	30	22
B-6	30		52							
B-7	2.5		200							
B-7	7.5		80					81	35	46
B-7	25		56							
B-7	50		53							
B-8	0		41							
B-8	5		77							
B-8	15		47							

SUMMARY OF LABORATORY DATA
(continued)

CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT (PERCENT)	PLASTIC LIMIT (PERCENT)	PLASTICITY INDEX (PERCENT)
B-8	25		45				64			
B-8	30		39							
B-9	0		34							
B-9	5		34							
B-9	7.5		71					84	35	49
B-9	15		50					59	26	33
B-9	25		46							
B-9	35		41				48			
B-9	50		36							
B-9	65		40							
B-10	0		22							
B-10	7.5		82							
B-10	20		46							
B-10	30		44				60			
B-10	40		42					53	27	26
B-10	55		50							
B-11	0		24							
B-11	5		49							
B-11	9.5		27							
B-11	35		41				66			
B-11	50		49							
B-11	65		53							
B-11	80		43							

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SUMMARY OF LABORATORY DATA

(continued)

CHINA CAMP CREEK
COQUILLE, OREGON

PBS PROJECT NUMBER:
90190.000

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT (PERCENT)	PLASTIC LIMIT (PERCENT)	PLASTICITY INDEX (PERCENT)
B-11	90		49					58	27	31
B-11	95		48							
B-11	120		34					39	23	16
B-11	130		35							
B-11	140		33							
Borrow	1		19					59	34	25

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FIGURE B5