Geotechnical Engineering Report

Mutual Materials
15791 SW Piazza Ave
Clackamas, Oregon

Prepared for:

North Clackamas School District
4444 SE Lake Road
Clackamas, Oregon 97222

May 30, 2019
PBS Project 22847.001

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1 INTRODUCTION

1.1 General

This report presents results of PBS Engineering and Environmental Inc. (PBS) geotechnical engineering services for the proposed development located at 15791 SW Piazza Ave in Clackamas, Oregon (site). The general site location is shown on the Vicinity Map, Figure 1. The locations of PBS' explorations in relation to existing and proposed site features are shown on the Site Plan, Figure 2.

1.2 Purpose and Scope

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

1.2.1 Literature and Records Review

PBS reviewed various published geologic maps of the area for information regarding geologic conditions and hazards at or near the site. PBS also reviewed previously completed reports for the project site and vicinity.

1.2.2 Subsurface Explorations

Six borings were advanced to depths ranging from approximately 6.5 to 11.5 feet below the existing ground surface (bgs) within the development footprint. The borings were logged and representative soil samples collected by a member of the PBS geotechnical engineering staff. The approximate boring locations are shown on the Site Plan, Figure 2. The interpreted boring logs are presented as Figures A1 through A6 in Appendix A, Field Explorations.

1.2.3 Field Infiltration Testing

One cased-hole, falling-head field infiltration test was completed in boring B-5 at a depth of approximately 5 feet bgs. Infiltration testing was monitored by PBS geotechnical engineering staff.

1.2.4 Soils Testing

Soil samples were returned to our laboratory and classified in general accordance with the Unified Soil Classification System (ASTM D2487) and/or the Visual-Manual Procedure (ASTM D2488). Laboratory tests included natural moisture contents, grain-size analyses, and Atterberg limits. Laboratory test results are included in the exploration logs in Appendix A, Field Explorations; and in Appendix B, Laboratory Testing.

1.2.5 Geotechnical Engineering Analysis

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

1.2.6 Report Preparation

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

- Field exploration logs and site plan showing approximate exploration locations
- Laboratory test results
- Infiltration test results
- Groundwater considerations
- Shallow foundation design recommendations:
    - Minimum embedment

  - Allowable bearing pressure
  - Estimated settlement (total and differential)
  - Sliding coefficient
- Earthwork and grading, cut, and fill recommendations:
  - Structural fill materials and preparation, and reuse of on-site soils
  - Wet weather considerations
  - Utility trench excavation and backfill requirements
  - Temporary and permanent slope inclinations
- Seismic design criteria in accordance with the 2014 Oregon Structural Specialty Code (OSSC)
- Slab and pavement subgrade preparation recommendations
- Recommended asphalt concrete (AC) pavement sections

1.3 Project Understanding

PBS understands that development of the 2-acre site will include a lightly loaded, single-story, pre-engineered metal building on the southern portion of the property and new parking areas with drive aisles. Based on our experience with similar projects, PBS estimates maximum building loads will be on the order of 50 kips for columns, 3 kips per linear foot for walls, and less than 250 pounds per square foot (psf) for floors.

2 SITE CONDITIONS

2.1 Surface Description

The rectangular-shaped site is bordered on the east by SE Piazza Avenue, and on the north, south, and west by commercial businesses. The site is currently in use as a hardscape and masonry supply business with associated parking and material storage areas. The site is currently occupied by a commercial building on the southeast corner used for product display and sales, a covered shed on the southwest corner, and a storage building on the west side of the property. Based on available topographic data, the site is relatively flat, with ground surface elevation being about 120 feet above mean sea level (amsl) across the site. Outside of the site, the ground surface is relatively flat in all directions.

2.2 Geologic Setting

The site is located on an abandoned river terrace associated with the Clackamas River within the southern portion of the Portland Basin. The Portland Basin is part of the larger physiographic province of the Puget-Willamette Lowland that separates the Cascade Range from the Coast Range, and extends from the Puget Sound to Eugene, Oregon (Yeats, et al., 1996). The Clackamas River is located less than a mile south of the site and occupies an east-west trending valley before joining the Willamette River. The adjacent hillsides consist primarily of volcanic rocks on the north and sedimentary and volcanic rocks to the south side (Madin, 2004). A series of cut-and-fill river terraces are inset within the valley and occupy either side of the river, with the youngest and lowest terrace forming confining bluffs 60 to 80 feet above the modern channel and floodplain (Ma, et al., 2012).

2.3 Subsurface Conditions

The site was explored by drilling six borings, designated B-1 through B-6, to depths of 6.5 to 11.5 feet bgs. The drilling was performed by Holt Services, Inc., of Vancouver, Washington, using a truck-mounted CME-75 drill rig and hollow-stem auger drilling techniques.

PBS has summarized the subsurface units as follows:

PAVEMENT:	All borings, except B-5, were drilled through 6 inches of AC pavement; boring B-5 was drilled in an area surfaced with gravel. The AC pavement was underlain by aggregate base course consisting of 1¼-inch-minus, angular crushed rock. The base aggregate ranged from 24 to 30 inches thick.
CLAY:	Medium stiff to very stiff clay with sand to gravel was encountered below the base aggregate in all borings except B-3. SPT N-values ranged from 5 to 29 blows per foot (bpf).
SAND:	Poorly graded sand was encountered below the clay in borings B-2 and B-5; clayey sand to sand with clay was encountered at approximately 4.5 feet bgs in borings B-5 and B-6. The sand was generally brown-gray and fine- to medium-grained. SPT N-values ranged from 22 to 64 bpf. Borings B-3 and B-6 terminated in poorly graded sand. The sand was generally very dense with SPT N-values ranging from 67 to 74 bpf.
GRAVEL:	Dense to very dense, poorly graded gravel was encountered below the clay in borings B-3 and B-6. The gravel was generally subangular, with variable amounts of sand and clay, and SPT N-values ranging from 12 to 64 bpf. Borings B-1, B-2, B-4, and B-5 terminated in poorly graded gravel. The gravel was generally subangular with coarse sand and SPT N-values ranging from 56 to greater than 50 blows for less than 6 inches of penetration.

2.4 Groundwater

Static groundwater was not encountered during our explorations to the depths explored. Based on a review of regional groundwater logs provided by the Oregon Water Resources Department (OWRD) and regional groundwater mapping by USGS, groundwater is likely present at depths of approximately 10 to 15 feet bgs. Please note that groundwater levels can fluctuate during the year depending on climate, irrigation season, extended periods of precipitation, drought, and other factors.

2.5 Infiltration Testing

PBS completed a cased-hole, falling-head infiltration test in boring B-5 at a depth of 5 feet bgs. The infiltration test was conducted within the 6.25-inch inside diameter, hollow-stem auger used to drill the boring. The auger was filled with water to achieve a minimum 1-foot-high column of water. After a period of saturation, the height of the water column in the pipe was then measured initially and at regular, timed intervals. Results of our field infiltration testing are presented in Table 1.

Table 1. Infiltration Test Results

Test Location	Depth (feet bgs)	Field Measured Infiltration Rate (in/hr)	Soil Classification
B-5	5	1.7	Clayey SAND (SC)

The infiltration rate listed in Table 1 is not a permeability/hydraulic conductivity, but a field-measured rate, and does not include correction factors related to long-term infiltration rates. The design engineer should determine the appropriate correction factors to account for the planned level of pre-treatment, maintenance, vegetation, siltation, etc. Field-measured infiltration rates are typically reduced by a minimum factor of 2 to 4 for use in design.

Soil types can vary significantly over relatively short distances. The infiltration rates noted above are representative of one discrete location and depth. Installation of infiltration systems within the layer the field rate was measured is considered critical to proper performance of the systems.

3 CONCLUSIONS AND RECOMMENDATIONS

3.1 Geotechnical Design Considerations

The subsurface conditions at the site consist of clay, sand, and gravel. Based on our observations and analyses, conventional foundation support on shallow spread footings is feasible for the proposed new building. Excavation with conventional equipment is feasible at the site.

The grading and final development plans for the project had not been completed when this report was prepared. Once completed, PBS should be engaged to review the project plans and update our recommendations as necessary.

3.2 Shallow Foundations

Shallow spread footings bearing on native soils may be used to support loads associated with the proposed development, provided the recommendations in this report are followed. Footings should not be supported on undocumented fill.

3.2.1 Minimum Footing Widths / Design Bearing Pressure

Continuous wall and isolated spread footings should be at least 18 and 24 inches wide, respectively. Footings should be sized using a maximum allowable bearing pressure of 3,000 pounds per square foot (psf). This is a net bearing pressure and the weight of the footing and overlying backfill can be disregarded in calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term live loads. Allowable bearing pressures may be increased by one-third for seismic and wind loads.

Footings will settle in response to column and wall loads. Based on our evaluation of the subsurface conditions and our analysis, we estimate post-construction settlement will be less than 1 inch for the column and perimeter foundation loads. Differential settlement will be on the order of one-half of the total settlement.

3.2.2 Footing Embedment Depths

PBS recommends that all footings be founded a minimum of 24 inches below the lowest adjacent grade. The footings should be founded below an imaginary line projecting upward at a 1H:1V (horizontal to vertical) slope from the base of any adjacent, parallel utility trenches or deeper excavations.

3.2.3 Footing Preparation

Excavations for footings should be carefully prepared to a neat and undisturbed state. A representative from PBS should confirm suitable bearing conditions and evaluate all exposed footing subgrades. Observations should also confirm that loose or soft materials have been removed from new footing excavations and concrete slab-on-grade areas. Localized deepening of footing excavations may be required to penetrate loose, wet, or deleterious materials.

PBS recommends a layer of compacted, crushed rock be placed over the footing subgrades to help protect them from disturbance due to foot traffic and the elements. Placement of this rock is the prerogative of the contractor; regardless, the footing subgrade should be in a dense or stiff condition prior to pouring concrete.

Based on our experience, approximately 4 inches of compacted crushed rock will be suitable beneath the footings.

3.2.4 Lateral Resistance

Lateral loads can be resisted by passive earth pressure on the sides of footings and grade beams, and by friction at the base of the footings. A passive earth pressure of 250 pounds per cubic foot (pcf) may be used for footings confined by native soils and new structural fills. The allowable passive pressure has been reduced by a factor of two to account for the large amount of deformation required to mobilize full passive resistance. Adjacent floor slabs, pavements, or the upper 12-inch depth of adjacent unpaved areas should not be considered when calculating passive resistance. For footings supported on native soils or new structural fills, use a coefficient of friction equal to 0.35 when calculating resistance to sliding. These values do not include a factor of safety (FS).

3.3 Floor Slabs

Satisfactory subgrade support for building floor slabs can be obtained from the native clayey sand and gravel subgrade prepared in accordance with our recommendations presented in the Site Preparation, Wet/Freezing Weather and Wet Soil Conditions, and Select Granular Fill sections of this report. A minimum 6-inch-thick layer of imported granular material should be placed and compacted over the prepared subgrade. Thicker aggregate sections may be necessary where undocumented fill is present, soft/loose soils are present at subgrade elevation, and/or during wet conditions. Imported granular material should be composed of crushed rock or crushed gravel that is relatively well graded between coarse and fine, contains no deleterious materials, has a maximum particle size of 1 inch, and has less than 5 percent by dry weight passing the US Standard No. 200 Sieve.

Floor slabs supported on a subgrade and base course prepared in accordance with the preceding recommendations may be designed using a modulus of subgrade reaction (k) of 150 pounds per cubic inch (pci).

3.4 Seismic Design Considerations

3.4.1 Code-Based Seismic Design Parameters

The current seismic design criteria for this project are based on the 2014 Oregon Structural Specialty Code (OSSC). Utilizing standard penetration test (SPT) N-values (standard penetration resistance), Site Class D is appropriate for use in design. The seismic design criteria, in accordance with the 2014 OSSC, are summarized in Table 2.

Table 2. 2014 OSSC Seismic Design Parameters

Parameter	Short Period	1 Second
Maximum Credible Earthquake Spectral Acceleration	S_s = 0.94 g	S_1 = 0.40 g
Site Class	D	
Site Coefficient	F_a = 1.13	F_v = 1.60
Adjusted Spectral Acceleration	S_{MS} = 1.05 g	S_{M1} = 0.64 g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.70 g	S_{D1} = 0.43 g

g= Acceleration due to gravity

3.4.2 Liquefaction Potential

Liquefaction is defined as a decrease in the shear resistance of loose, saturated, cohesionless soil (e.g., sand) or low plasticity silt soils, due to the buildup of excess pore pressures generated during an earthquake. This results in a temporary transformation of the soil deposit into a viscous fluid. Liquefaction can result in ground settlement, foundation bearing capacity failure, and lateral spreading of ground.

Based on a review of the Oregon Statewide Geohazard Viewer (HazVu), the site is shown as not having a liquefaction hazard. This is consistent with the soil types and relative density of site soils encountered in our explorations.

3.5 Ground Moisture

The perimeter ground surface and hardscape should be sloped to drain away from all structures and away from adjacent slopes. Gutters should be tight-lined to a suitable discharge and maintained as free-flowing. All crawl spaces should be adequately ventilated and sloped to drain to a suitable, exterior discharge.

3.6 Pavement Design

Our pavement recommendations were developed using the American Association of State Highway and Transportation Officials (AASHTO) design methods and references the associated Oregon Department of Transportation (ODOT) specifications for construction. Our evaluation considered a total of 165 buses entering and exiting the site twice per day, during weekdays, and a 20-year design life. Roughly half the traffic will enter/leave the site from each of the two proposed entrances and exits to SE Piazza Avenue and SE 102nd Avenue, approximately one-third of the traffic will use the main bus lanes, and the remainder of traffic will cross the secondary bus parking strips.

The minimum recommended pavement section thicknesses are provided in Table 3. Depending on weather conditions at the time of construction, a thicker aggregate base course section could be required to support construction traffic during preparation and placement of the pavement section.

Table 3. Minimum AC Pavement Sections

Traffic Loading	AC (inches)	Base Course (inches)	Subgrade*
Passenger Vehicle/Parking	3	6	Stiff subgrade as verified by PBS personnel
Entrances/Exits	6	12	
Main Bus Lanes	5.5	12	
Secondary Bus Parking Strips	5	10	

* Subgrade must pass proofroll

The asphalt cement binder should be selected following ODOT SS 00744.11 – Asphalt Cement and Additives. The AC should consist of ½-inch hot mix asphalt concrete (HMAC) with a maximum lift thickness of 3 inches. The AC should conform to ODOT SS 00744.13 and 00744.14 and be compacted to 91 percent of the maximum theoretical density (Rice value) of the mix, as determined in accordance with ASTM D2041.

Heavy construction traffic on new pavements or partial pavement sections (such as base course over the prepared subgrade) will likely exceed the design loads and could potentially damage or shorten the pavement life; therefore, we recommend construction traffic not be allowed on new pavements, or that the contractor take appropriate precautions to protect the subgrade and pavement during construction.

If construction traffic is to be allowed on newly constructed road sections, an allowance for this additional traffic will need to be made in the design pavement section.

4 CONSTRUCTION RECOMMENDATIONS

4.1 Site Preparation

Construction of the proposed development will involve clearing and grubbing of the existing vegetation and demolition of existing structures and pavement. Demolition should include removal of existing pavement, utilities, etc., throughout the proposed new development. Underground utility lines or other abandoned structural elements should also be removed. The voids resulting from removal of foundations or loose soil in utility lines should be backfilled with compacted structural fill. The base of these excavations should be excavated to firm native subgrade before filling, with sides sloped at a minimum of 1H:1V to allow for uniform compaction. Materials generated during demolition should be transported off site or stockpiled in areas designated by the owner's representative.

4.1.1 Proofrolling/Subgrade Verification

Following site preparation and prior to placing aggregate base over shallow foundation, floor slab, and pavement subgrades, the exposed subgrade should be evaluated either by proofrolling or another method of subgrade verification. The subgrade should be proofrolled with a fully loaded dump truck or similar heavy, rubber-tire construction equipment to identify unsuitable areas. If evaluation of the subgrades occurs during wet conditions, or if proofrolling the subgrades will result in disturbance, they should be evaluated by PBS using a steel foundation probe. We recommend that PBS be retained to observe the proofrolling and perform the subgrade verifications. Unsuitable areas identified during the field evaluation should be compacted to a firm condition or be excavated and replaced with structural fill.

4.1.2 Wet/Freezing Weather and Wet Soil Conditions

Due to the presence of fine-grained clay and sands in the near-surface materials 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 the optimum moisture required for compaction. Soils disturbed during site preparation activities, or unsuitable areas identified during proofrolling or probing, should be removed and replaced with compacted structural fill.

Site earthwork and subgrade preparation should not be completed during freezing conditions, except for mass excavation to the subgrade design elevations.

Protection of the subgrade is the responsibility of the contractor. Construction of granular haul roads to the project site entrance may help reduce further damage to the pavement and disturbance of site soils. The actual thickness of haul roads and staging areas should be based on the contractors' approach to site development, and the amount and type of construction traffic. The imported granular material should be placed in one lift over the prepared undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. A geotextile fabric should be used to separate the subgrade from the imported granular material in areas of repeated construction traffic. The geotextile should meet the specifications of ODOT SS Section 02320.10 and SS 02320.20, Table 02320-1 for soil separation. The geotextile should be installed in conformance with ODOT SS 00350.00 – Geosynthetic Installation.

4.1.3 Dry Weather Conditions

Clay soils should be covered within 4 hours of exposure by a minimum of 4 inches of crushed rock or plastic sheeting during the dry season. Exposure of these materials should be coordinated with the geotechnical engineer so that the subgrade suitability can be evaluated prior to being covered.

4.2 Excavation

The near-surface soils at the site can be excavated with conventional earthwork equipment. Sloughing and caving should be anticipated. All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor is solely responsible for adherence to the OSHA requirements. 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 provided the excavation is configured in accordance with the OSHA requirements, groundwater seepage is not present, and with the understanding that some sloughing may occur. Trenches/excavations should be flattened if sloughing occurs or seepage is present. Use of a trench shield or other approved temporary shoring is recommended if vertical walls are desired for cuts deeper than 4 feet bgs. 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 the overall plan of operation.

4.3 Structural Fill

The extent of site grading is currently unknown; however, PBS estimates that cuts and fills will be less than about 2 feet. Structural fill should be placed over subgrade that has been prepared in conformance with the Site Preparation and Wet/Freezing Weather and Wet Soil Conditions sections of this report. Structural fill material should consist of relatively well-graded soil, or an approved rock product that is free of organic material and debris, and contains particles not greater than 4 inches nominal dimension.

The suitability of soil for use as compacted structural fill will depend on the gradation and moisture content of the soil when it is placed. As the amount of fines (material finer than the US Standard No. 200 Sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and compaction becomes more difficult to achieve. Soils containing more than about 5 percent fines cannot consistently be compacted to a dense, non-yielding condition when the water content is significantly greater (or significantly less) than optimum.

If fill and excavated material will be placed on slopes steeper than 5H:1V, these must be keyed/benched into the existing slopes and installed in horizontal lifts. Vertical steps between benches should be approximately 2 feet.

4.3.1 On-Site Soil

On-site soils encountered in our explorations are generally suitable for placement as structural fill during moderate, dry weather when moisture content can be maintained by air drying and/or addition of water. The fine-grained fraction of the site soils are 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 fine-grained soils may be required. The material should be placed in lifts with a maximum uncompacted thickness of approximately 8 inches and compacted to at least 92 percent of the maximum dry density, as determined by ASTM D1557 (modified proctor).

4.3.2 Borrow Material

Borrow material for general structural fill construction should meet the requirements set forth in ODOT SS 00330.12 – Borrow Material. When used as structural fill, borrow material should be placed in lifts with a maximum uncompacted thickness of approximately 8 inches and compacted to not less than 92 percent of the maximum dry density, as determined by ASTM D1557.

4.3.3 Select Granular Fill

Selected granular backfill used during periods of wet weather for structural fill construction should meet the specifications provided in ODOT SS 00330.14 – Selected Granular Backfill. The imported granular material should be uniformly moisture conditioned to within about 2 percent of the optimum moisture content and compacted in relatively thin lifts using suitable mechanical compaction equipment. Selected granular backfill should be placed in lifts with a maximum uncompacted thickness of 8 to 12 inches and be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557.

4.3.4 Crushed Aggregate Base

Crushed aggregate base course below floor slabs, spread footings, and asphalt concrete pavements should be clean crushed rock or crushed gravel that contains no deleterious materials and meets the specifications provided in ODOT SS 02630.10 – Dense-Graded Aggregate, and has less than 5 percent by dry weight passing the US Standard No. 200 Sieve. The crushed aggregate base course should be placed in lifts with a maximum uncompacted thickness of 8 to 12 inches and be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

4.3.5 Utility Trench Backfill

Pipe bedding placed to uniformly support the barrel of pipe should meet specifications provided in ODOT SS 00405.12 – Pipe Zone Bedding. The pipe zone that extends from the top of the bedding to at least 8 inches above utility lines should consist of material prescribed by ODOT SS 00405.13 – Pipe Zone Material. The pipe zone material should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer.

Under pavements, paths, slabs, or beneath building pads, the remainder of the trench backfill should consist of well-graded granular material with less than 10 percent by dry weight passing the US Standard No. 200 Sieve, and should meet standards prescribed by ODOT SS 00405.14 – Trench Backfill, Class B or D. This material should be compacted to at least 92 percent of the maximum dry density, as determined by ASTM D1557 or as required by the pipe manufacturer. The upper 2 feet of the trench backfill should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557. Controlled low-strength material (CLSM), ODOT SS 00405.14 – Trench Backfill, Class E, can be used as an alternative.

Outside of structural improvement areas (e.g., pavements, sidewalks, or building pads), trench material placed above the pipe zone may consist of general structural fill materials that are free of organics and meet ODOT SS 00405.14 – Trench Backfill, Class A. This general trench backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local jurisdictions.

4.3.6 Stabilization Material

Stabilization rock should consist of pit or quarry run rock that is well-graded, angular, crushed rock consisting of 4- or 6-inch-minus material with less than 5 percent passing the US Standard No. 4 Sieve. The material should be free of organic matter and other deleterious material. ODOT SS 00330.16 – Stone Embankment Material can be used as a general specification for this material with the stipulation of limiting the maximum size to 6 inches.

5 ADDITIONAL SERVICES AND CONSTRUCTION OBSERVATIONS

In most cases, other services beyond completion of a final geotechnical engineering report are necessary or desirable to complete the project. Occasionally, conditions or circumstances arise that require 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 pile installation. 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 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 express 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. 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 fill, 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 completing explorations such as 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 work 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.

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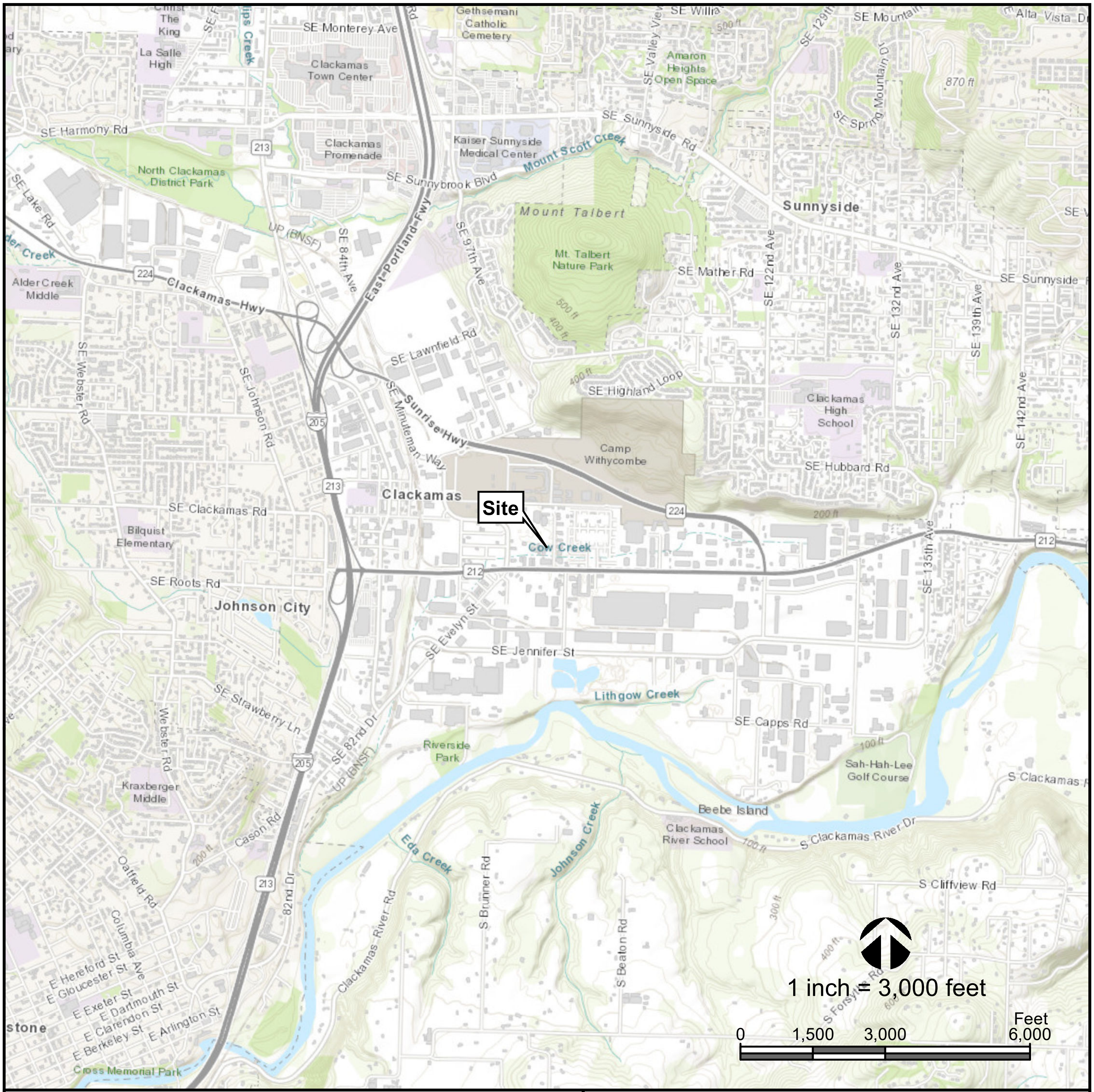
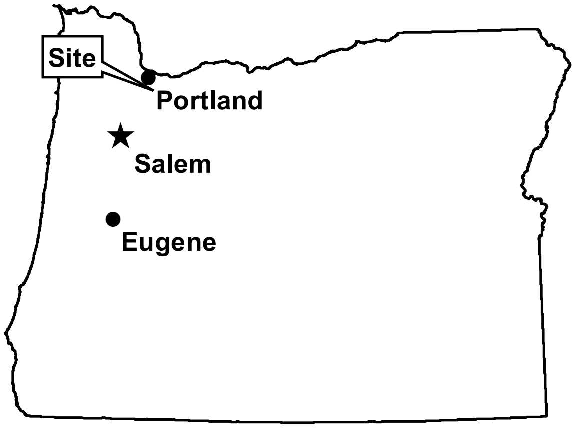
Figures





VICINITY MAP

MUTUAL MATERIALS
CLACKAMAS, OREGON

DATE: MAY 2019 · PROJECT: 22847.001

PBS

FIGURE

1

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EXPLANATION

- B-1 - Boring name and approximate location
- 🟦 Approximate site boundary

SOURCES: Google Earth 2018

SITE PLAN

MUTUAL MATERIALS
CLACKAMAS, OREGON

DATE: MAY 2019 · PROJECT: 22847.001

PBS

FIGURE
2

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Appendix A

Field Explorations

Appendix A: Field Explorations

A1 GENERAL

PBS explored subsurface conditions at the project site by advancing six borings to depths of up to approximately 11.5 feet bgs on April 30, 2019. The approximate locations of the explorations are shown on Figure 2, Site Plan. The procedures 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 engineering practices in general accordance with relevant ASTM procedures. "General accordance" means that certain local drilling/excavation and descriptive practices and methodologies have been followed.

A2 BORINGS

A2.1 Drilling

Borings were advanced using a truck-mounted CME-75 drill rig provided and operated by Holt Services, Inc., of Vancouver, Washington, using hollow-stem auger drilling techniques. The borings were observed by a member of the PBS geotechnical staff, who 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 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 (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 a member of the PBS geotechnical staff and then sealed in plastic bags for further examination and physical testing in our laboratory.

A2.3 Boring Logs

The boring 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. The N-values and natural water (moisture) contents are shown farther to the right.

A3 MATERIAL DESCRIPTION

Initially, samples were classified visually in the field. Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the soil samples were noted. Afterward, the samples were reexamined 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 Table A-1, Terminology Used to Describe Soil.

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 on total dry weight, is the primary soil type and is capitalized in our log descriptions (SAND, GRAVEL, SILT, or CLAY). Smaller percentages of other constituents in the soil mixture are indicated by use of modifier words in general accordance with the ASTM D2488-06 Visual-Manual Procedure. “General Accordance” means that certain local and common descriptive practices may have been followed. In accordance with ASTM D2488-06, group symbols (such as GP or CH) are applied on the portion of soil passing the 3-inch (75mm) sieve based on visual examination. The following describes the use of soil names and modifying terms used to describe fine- and coarse-grained soils.

Fine-Grained Soils (50% or greater fines passing 0.075 mm, No. 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 outlines the terminology used to describe fine-grained soils, and varies from ASTM D2488 terminology in the use of some common terms.

Primary soil NAME, Symbols, and Adjectives			Plasticity Description	Plasticity Index (PI)
SILT (ML & MH)	**CLAY (CL & CH)**	**ORGANIC SOIL (OL & OH)**		
SILT		Organic SILT	Non-plastic	0 – 3
SILT		Organic SILT	Low plasticity	4 – 10
SILT/Elastic SILT	Lean CLAY	Organic SILT/ Organic CLAY	Medium Plasticity	10 – 20
Elastic SILT	Lean/Fat CLAY	Organic CLAY	High Plasticity	20 – 40
Elastic SILT	Fat CLAY	Organic CLAY	Very Plastic	>40

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

Description	% Composition	
With Sand	% Sand ≥ % Gravel	15% to 25% plus No. 200
With Gravel	% Sand < % Gravel	
Sandy	% Sand ≥ % Gravel	≤30% to 50% plus No. 200
Gravelly	% Sand < % Gravel	

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

Soil 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. SILT soils with low to non-plastic behavior (i.e., PI < 7) may be classified using relative density.

Consistency Term	SPT N-value	Unconfined Compressive Strength	
		tsf	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

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 the portion of materials passing a 3-inch (75mm) sieve. Coarse-grained soil group symbols are applied in accordance with ASTM D2488-06 based on 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 NAME	Particle Diameter	
	Inches	Millimeters
SAND (SW or SP)	0.003 – 0.19	0.075 – 4.8
GRAVEL (GW or GP)	0.19 – 3	4.8 – 75
Additional Constituents:		
Cobble	3 – 12	75 – 300
Boulder	12 – 120	300 – 3050

The primary soil type is capitalized, and the fines content in the soil are described as indicated by the following examples. Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 percent. Other soil mixtures will have similar descriptive names.

Example: Coarse-Grained Soil Descriptions with Fines

>5% to < 15% fines (Dual Symbols)	≥15% to < 50% fines
Well graded GRAVEL with silt: GW-GM	Silty GRAVEL: GM
Poorly graded SAND with clay: SP-SC	Silty SAND: SM

Additional descriptive terminology applied to coarse-grained soils follow.

Example: Coarse-Grained Soil Descriptions with Other Coarse-Grained Constituents

Coarse-Grained Soil Containing Secondary Constituents	
With sand or with gravel	≥ 15% sand or gravel
With cobbles; with boulders	Any amount of cobbles or boulders.

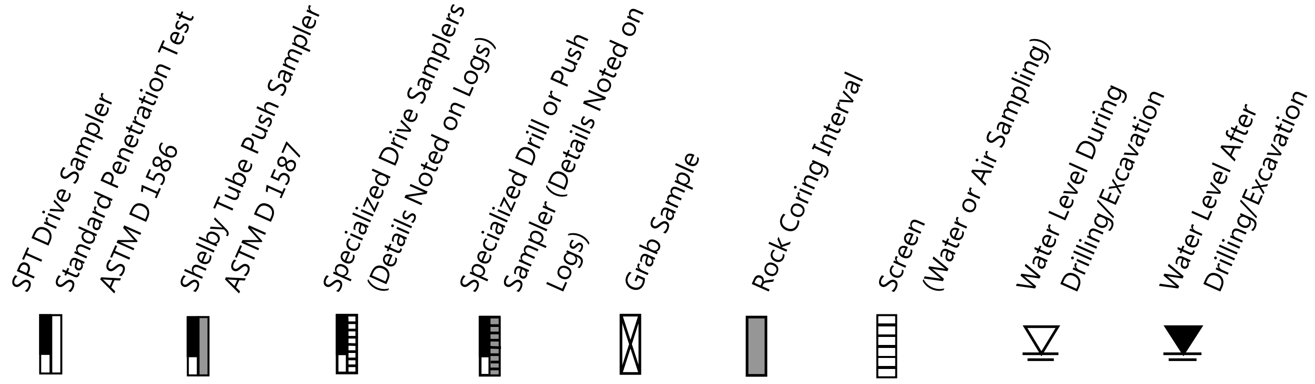
Cobble and boulder deposits may include a description of the matrix soils, as defined above.

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	5 – 10
Medium dense	11 – 30
Dense	31 – 50
Very dense	> 50

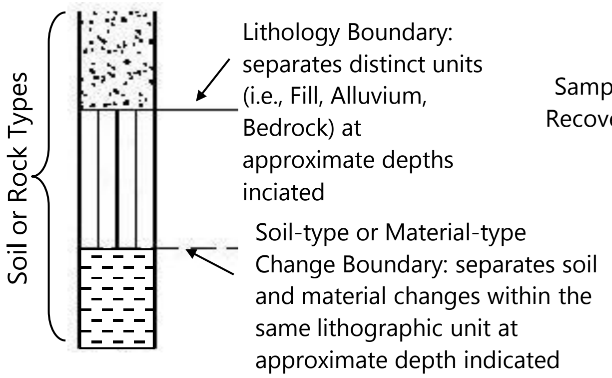
Table A-2
Key To Test Pit and Boring Log Symbols

SAMPLING DESCRIPTIONS

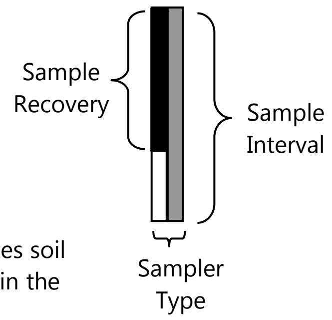


LOG GRAPHICS

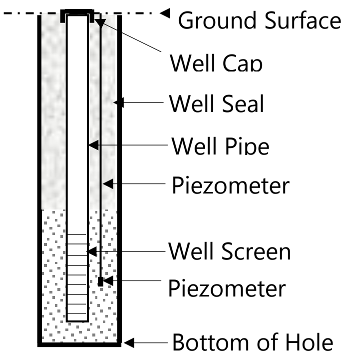
Soil and Rock



Sampling Symbols



Instrumentation Detail



Geotechnical Testing Acronym Explanations

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

Details of soil and rock classification systems are available on request.

Rev. 02/2017

MUTUAL MATERIALS
CLACKAMAS, OREGON

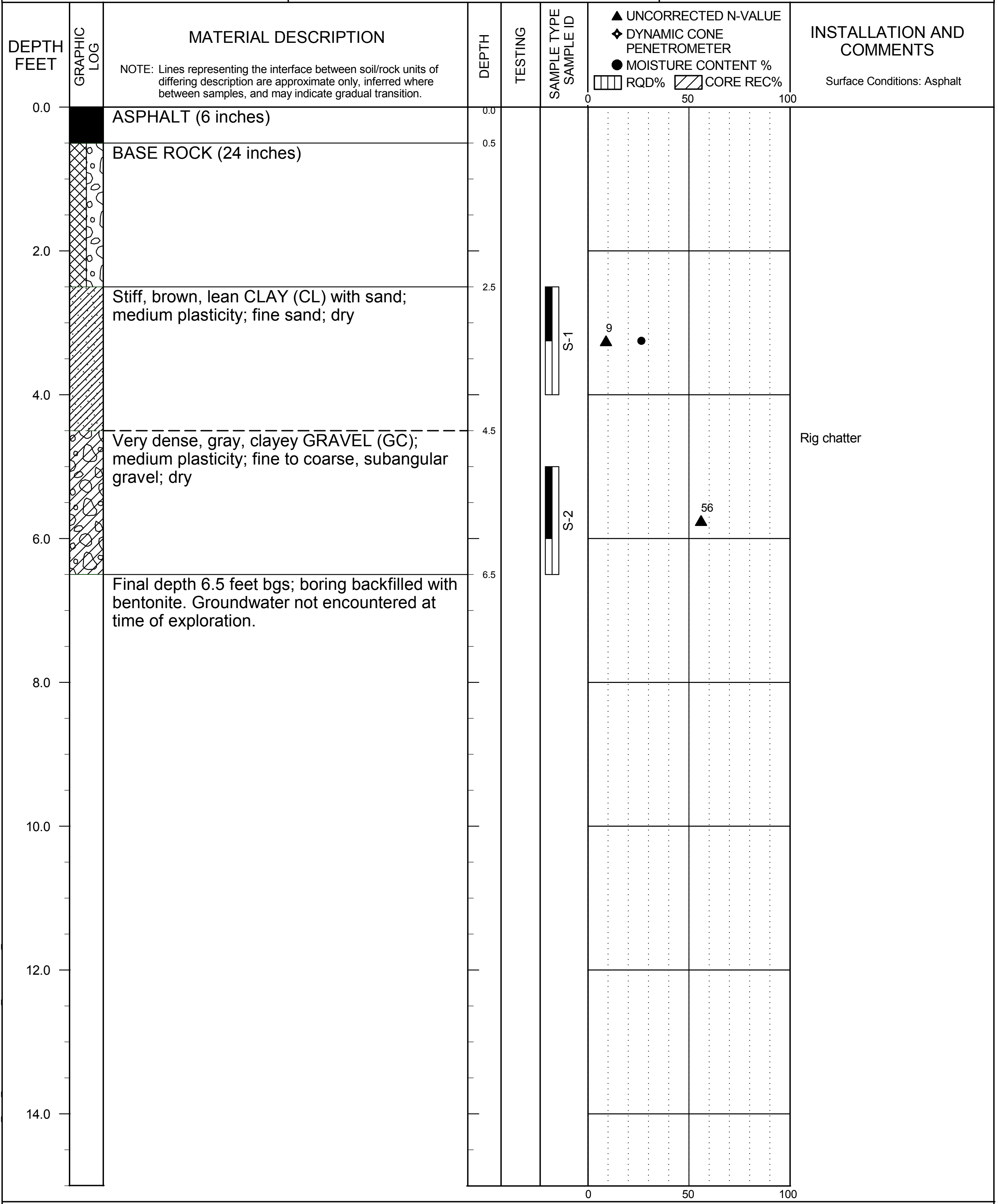
PBS PROJECT NUMBER:
22847.001

BORING B-1

APPROX. BORING B-1 LOCATION:
45.408932, -122.555132

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

Surface Conditions: Asphalt



DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	SAMPLE ID	UNCORRECTED N-VALUE	INSTALLATION AND COMMENTS
0.0	ASPHALT (6 inches)	0.0			
0.5	BASE ROCK (24 inches)	0.5			
2.5	Stiff, brown, lean CLAY (CL) with sand; medium plasticity; fine sand; dry	2.5	S-1	9	
4.5	Very dense, gray, clayey GRAVEL (GC); medium plasticity; fine to coarse, subangular gravel; dry	4.5	S-2	56	Rig chatter
6.5	Final depth 6.5 feet bgs; boring backfilled with bentonite. Groundwater not encountered at time of exploration.	6.5			

DRILLING METHOD: Hollow-Stem Auger
DRILLED BY: Holt Services, Inc.
LOGGED BY: T. Laird

BIT DIAMETER: 4 ¼ inches
HAMMER EFFICIENCY PERCENT: 86.5
LOGGING COMPLETED: 4/30/19

FIGURE A1

PBS	MUTUAL MATERIALS CLACKAMAS, OREGON	**BORING B-2**
	PBS PROJECT NUMBER: 22847.001	APPROX. BORING B-2 LOCATION: 45.408777, -122.555465

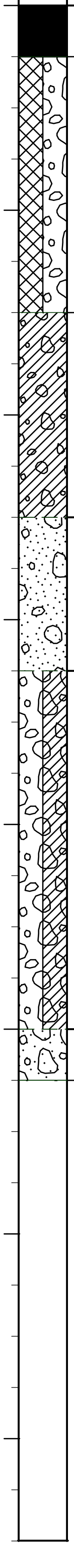
MATERIAL DESCRIPTION

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

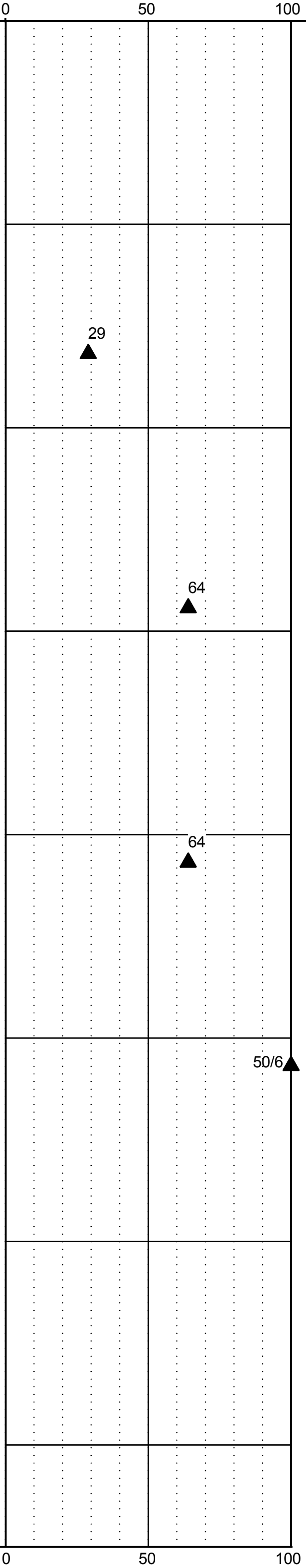
▲ UNCORRECTED N-VALUE
✧ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD% ▨ CORE REC%

INSTALLATION AND COMMENTS

Surface Conditions: Asphalt



DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	UNCORRECTED N-VALUE	INSTALLATION AND COMMENTS
0.0	ASPHALT (6 inches)	0.0				
	BASE ROCK (30 inches)	0.5				
2.0						
	Very stiff, brown, gravelly lean CLAY (CL); medium plasticity; fine to coarse, subangular gravel; moist	3.0		S-1	29	
4.0						
	Very dense, brown, poorly graded SAND (SP) with gravel; medium to coarse sand; fine to coarse, subangular gravel; moist	5.0		S-2	64	
6.0						Rig chatter
	Very dense, gray, poorly graded GRAVEL (GP-GC) with clay and sand; medium plasticity; medium to coarse sand; coarse, subangular gravel; moist	6.5		S-3	64	
8.0						
10.0	Very dense, gray, poorly graded GRAVEL (GP) with sand; medium to coarse sand; fine to coarse, subangular gravel; moist	10.0		S-4	50/6	
	Final depth 10.5 feet bgs due to refusal in very dense gravel; boring backfilled with bentonite. Groundwater not encountered at time of exploration.	10.5				
12.0						
14.0						



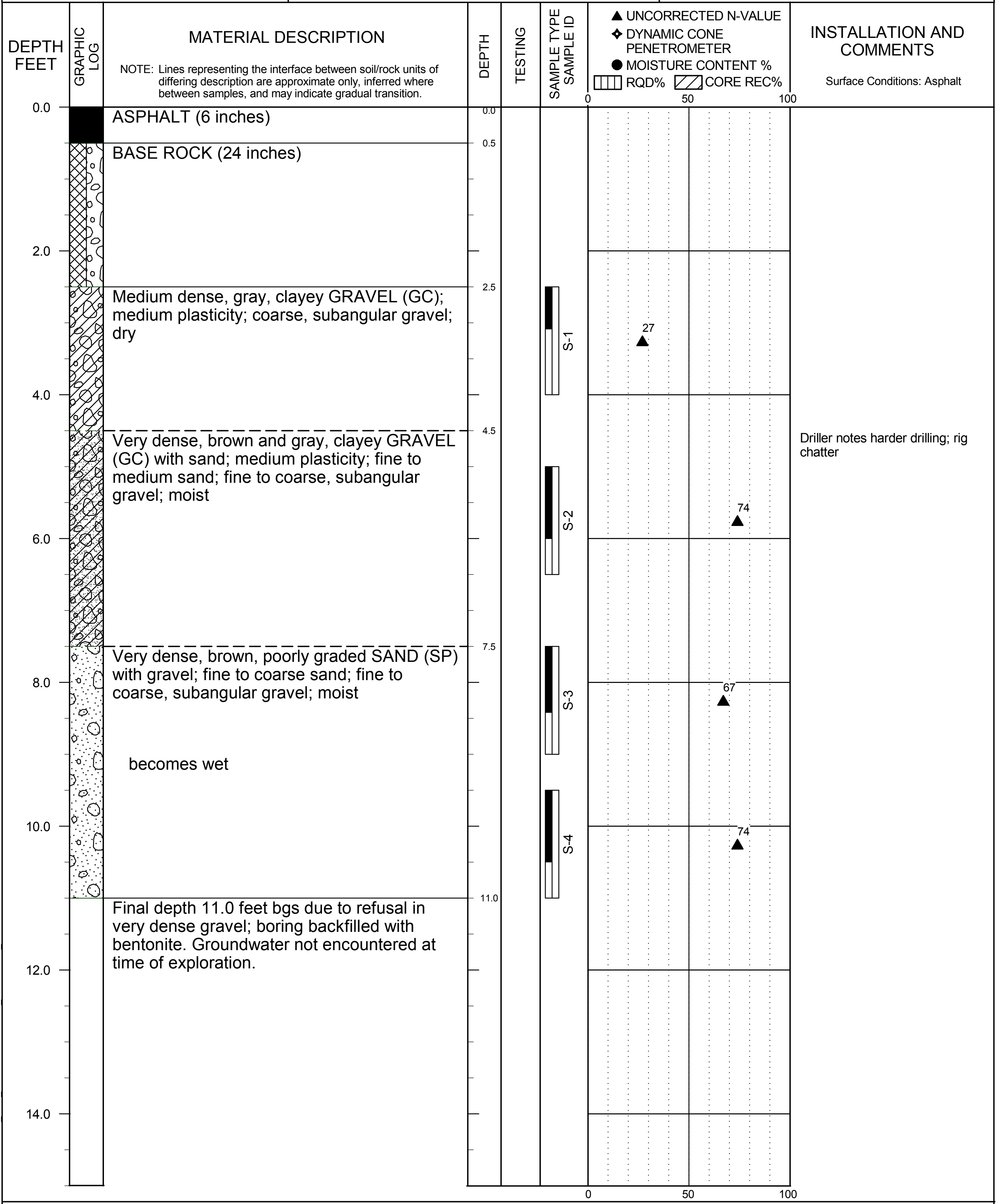
DRILLING METHOD: Hollow-Stem Auger DRILLED BY: Holt Services, Inc. LOGGED BY: T. Laird	BIT DIAMETER: 4 ¼ inches HAMMER EFFICIENCY PERCENT: 86.5 LOGGING COMPLETED: 4/30/19

FIGURE A2

Page 1 of 1

BORING LOG 22847.001 B1-6 20190506.GPJ PBS DATATMPL GEO.GDT PRINT DATE: 5/29/19:RPG

MUTUAL MATERIALS CLACKAMAS, OREGON	**BORING B-3**
PBS PROJECT NUMBER: 22847.001	APPROX. BORING B-3 LOCATION: 45.408879, -122.555890



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.

▲ UNCORRECTED N-VALUE
✥ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%

INSTALLATION AND COMMENTS

Surface Conditions: Asphalt

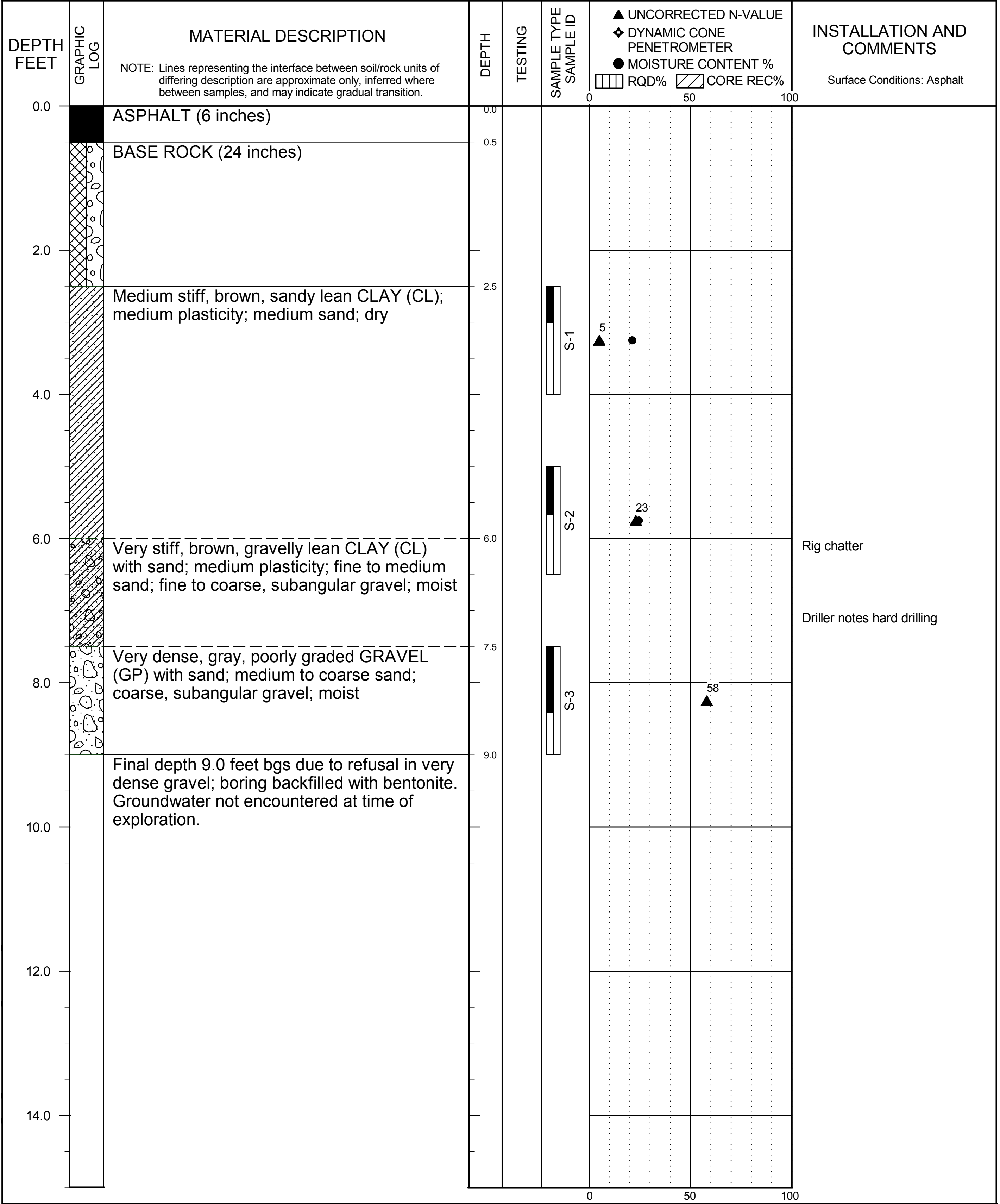
DEPTH	MATERIAL DESCRIPTION	SAMPLE ID	UNCORRECTED N-VALUE	INSTALLATION AND COMMENTS
0.0	ASPHALT (6 inches)			
0.5	BASE ROCK (24 inches)			
2.5	Medium dense, gray, clayey GRAVEL (GC); medium plasticity; coarse, subangular gravel; dry	S-1	27	
4.5	Very dense, brown and gray, clayey GRAVEL (GC) with sand; medium plasticity; fine to medium sand; fine to coarse, subangular gravel; moist	S-2	74	Driller notes harder drilling; rig chatter
7.5	Very dense, brown, poorly graded SAND (SP) with gravel; fine to coarse sand; fine to coarse, subangular gravel; moist	S-3	67	
	becomes wet	S-4	74	
11.0	Final depth 11.0 feet bgs due to refusal in very dense gravel; boring backfilled with bentonite. Groundwater not encountered at time of exploration.			

DRILLING METHOD: Hollow-Stem Auger
DRILLED BY: Holt Services, Inc.
LOGGED BY: T. Laird

BIT DIAMETER: 4 ¼ inches
HAMMER EFFICIENCY PERCENT: 86.5
LOGGING COMPLETED: 4/30/19

FIGURE A3

PBS	MUTUAL MATERIALS CLACKAMAS, OREGON	**BORING B-4**
	PBS PROJECT NUMBER: 22847.001	APPROX. BORING B-4 LOCATION: 45.409145, -122.555531



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.

INSTALLATION AND COMMENTS

Surface Conditions: Asphalt

DEPTH	MATERIAL DESCRIPTION	SAMPLE ID	UNCORRECTED N-VALUE	INSTALLATION AND COMMENTS
0.0	ASPHALT (6 inches)			
0.5	BASE ROCK (24 inches)			
2.5	Medium stiff, brown, sandy lean CLAY (CL); medium plasticity; medium sand; dry	S-1	5	
		S-2	23	
6.0	Very stiff, brown, gravelly lean CLAY (CL) with sand; medium plasticity; fine to medium sand; fine to coarse, subangular gravel; moist			Rig chatter Driller notes hard drilling
7.5	Very dense, gray, poorly graded GRAVEL (GP) with sand; medium to coarse sand; coarse, subangular gravel; moist	S-3	58	
9.0	Final depth 9.0 feet bgs due to refusal in very dense gravel; boring backfilled with bentonite. Groundwater not encountered at time of exploration.			

BORING LOG 22847.001 B1-6 20190506.GPJ PBS DATATMPL GEO.GDT PRINT DATE: 5/29/19:RPG

DRILLING METHOD: Hollow-Stem Auger
DRILLED BY: Holt Services, Inc.
LOGGED BY: T. Laird

BIT DIAMETER: 4 ¼ inches
HAMMER EFFICIENCY PERCENT: 86.5
LOGGING COMPLETED: 4/30/19

FIGURE A4

MUTUAL MATERIALS
CLACKAMAS, OREGON

BORING B-5

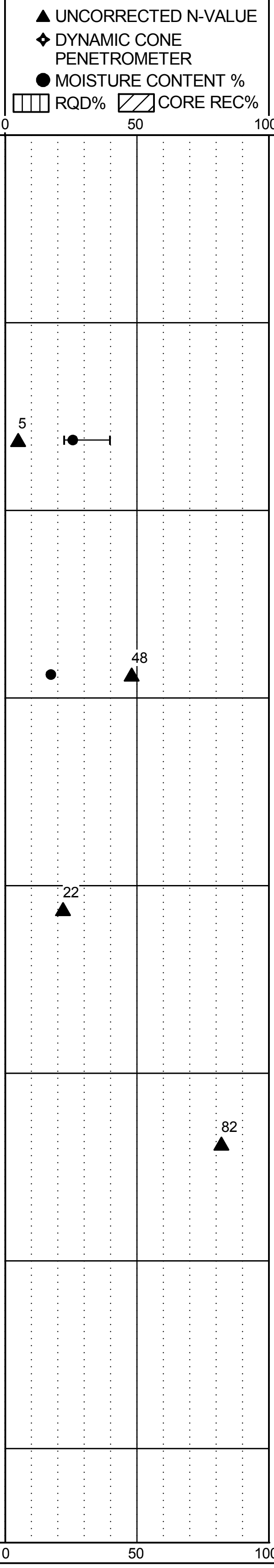
PBS PROJECT NUMBER:
22847.001

APPROX. BORING B-5 LOCATION:
45.409381, -122.555774

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

Surface Conditions: Crushed Gravel

DEPTH	MATERIAL DESCRIPTION	TESTING	SAMPLE TYPE SAMPLE ID	UNCORRECTED N-VALUE	INSTALLATION AND COMMENTS
0.0	GRAVEL FILL (24 inches)				
2.0	Medium stiff, brown, sandy lean CLAY (CL); medium plasticity; medium sand; dry	ATT	S-1	5	LL = 40 PL = 22 PI = 18
4.5	Dense, brown, clayey SAND (SC) with gravel; medium plasticity; fine to medium sand; fine to coarse, subangular gravel; moist	P200	S-2	48	Driller notes harder drilling; rig chatter P200 = 14% Infiltration testing completed at 5 feet bgs; switched to 4.25-inch auger after 5 feet due to difficult drilling
	becomes brown to reddish brown; with medium to coarse sand and decreased gravel		S-3	22	
9.0	Very dense, brown to gray, poorly graded GRAVEL (GP) with sand; medium to coarse sand; fine to coarse, subangular gravel; moist		S-4	82	
11.5	Final depth 11.5 feet bgs; boring backfilled with bentonite. Groundwater not encountered at time of exploration.				



DRILLING METHOD: Hollow-Stem Auger
DRILLED BY: Holt Services, Inc.
LOGGED BY: T. Laird

BIT DIAMETER: 6 ¼ inches
HAMMER EFFICIENCY PERCENT: 86.5
LOGGING COMPLETED: 4/30/19

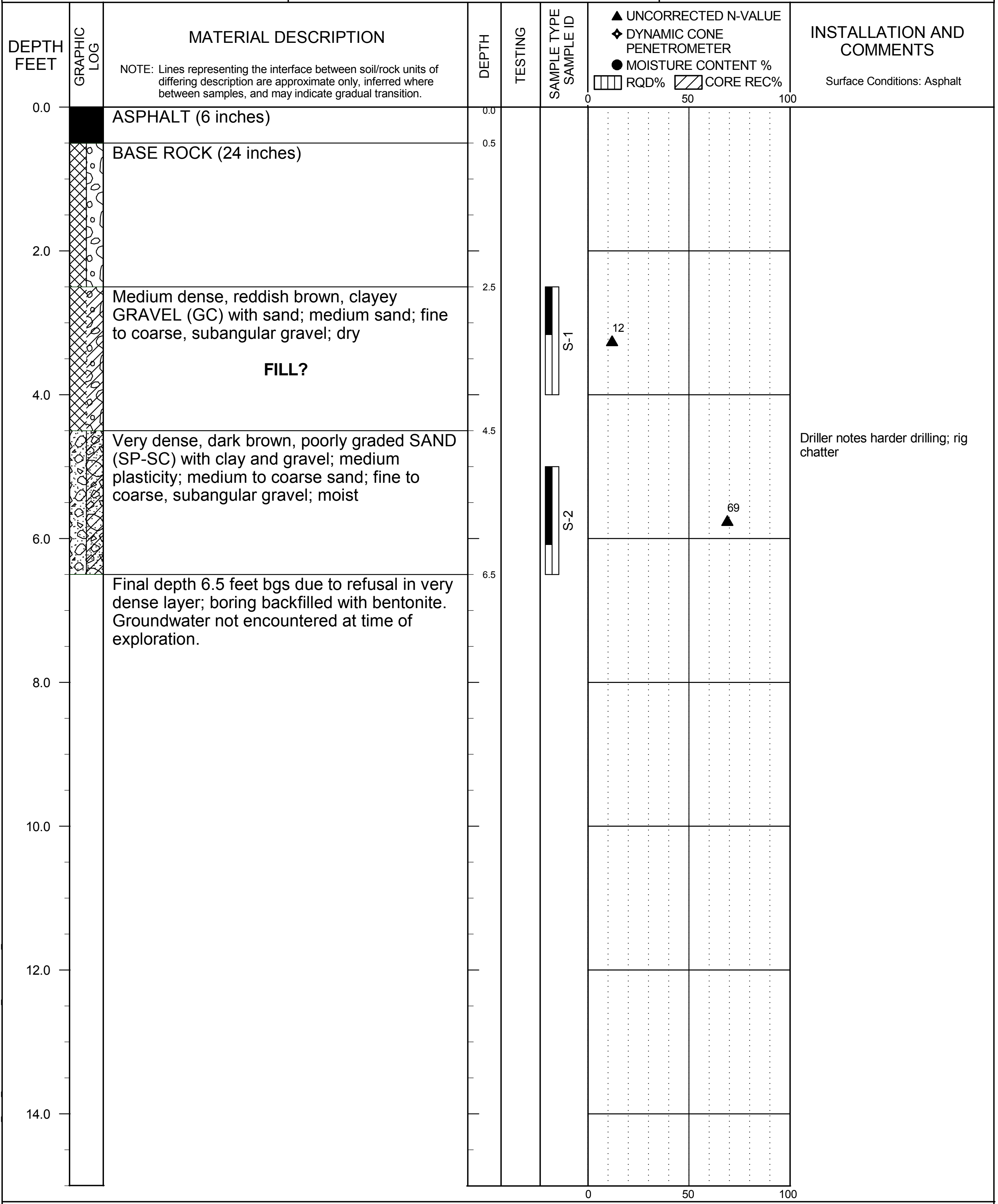
FIGURE A5
Page 1 of 1

MUTUAL MATERIALS
CLACKAMAS, OREGON

BORING B-6

PBS PROJECT NUMBER:
22847.001

APPROX. BORING B-6 LOCATION:
45.409385, -122.555313



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.

INSTALLATION AND COMMENTS

Surface Conditions: Asphalt

DEPTH	MATERIAL DESCRIPTION	SAMPLE ID	UNCORRECTED N-VALUE	INSTALLATION AND COMMENTS
0.0	ASPHALT (6 inches)			
0.5	BASE ROCK (24 inches)			
2.5	Medium dense, reddish brown, clayey GRAVEL (GC) with sand; medium sand; fine to coarse, subangular gravel; dry **FILL?**	S-1	12	
4.5	Very dense, dark brown, poorly graded SAND (SP-SC) with clay and gravel; medium plasticity; medium to coarse sand; fine to coarse, subangular gravel; moist	S-2	69	Driller notes harder drilling; rig chatter
6.5	Final depth 6.5 feet bgs due to refusal in very dense layer; boring backfilled with bentonite. Groundwater not encountered at time of exploration.			

DRILLING METHOD: Hollow-Stem Auger
DRILLED BY: Holt Services, Inc.
LOGGED BY: T. Laird

BIT DIAMETER: 4 ¼ inches
HAMMER EFFICIENCY PERCENT: 86.5
LOGGING COMPLETED: 4/30/19

FIGURE A6

Appendix B

Laboratory Testing

Appendix B: Laboratory Testing

B1 GENERAL

Samples obtained during the field explorations were examined in the PBS laboratory. The physical characteristics of the samples were noted and field classifications were modified where necessary. During the course of examination, representative samples were selected for further testing. The testing program for the soil samples included standard classification tests, which yield certain index properties of the soils important to an evaluation of soil behavior. The testing procedures are described in the following paragraphs. Unless noted otherwise, all test procedures are in general accordance with applicable ASTM standards. "General accordance" means that certain local and common descriptive practices and methodologies have been followed.

B2 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 (that is, gravel, sand, silt, or clay) the term that best described the major portion of the sample is used. Modifying terminology to further describe the samples is defined in Table A-1, Terminology Used to Describe Soil, in Appendix A.

B2.2 Moisture (Water) Contents

Natural moisture content determinations were made on samples of the fine-grained soils (that is, 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 and on Figure B2, Summary of Laboratory Data, in Appendix B.

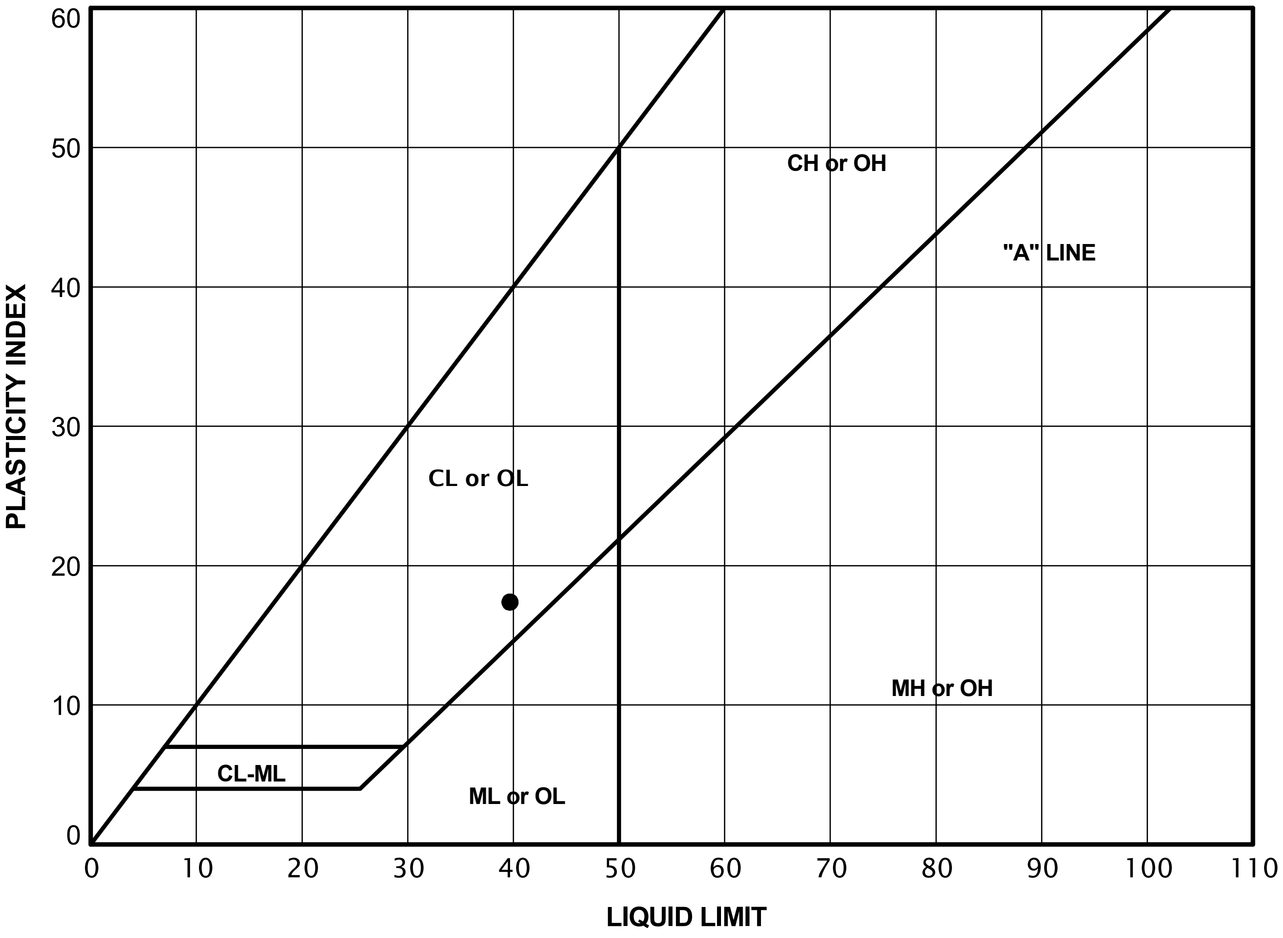
B2.3 Atterberg Limits

Atterberg limits were determined on select samples for the purpose of classifying soils into various groups for correlation. The results of the Atterberg limits test, which included liquid and plastic limits, are plotted on Figure B1, Atterberg Limits Test Results, and on the explorations logs in Appendix A where applicable.

B2.4 Grain-Size Analyses (P200 Wash)

Washed sieve analyses (P200) were completed on samples to determine the portion of soil samples passing the No. 200 Sieve (i.e., silt and clay). The results of the P200 test results are presented on the exploration logs in Appendix A and on Figure B2, Summary of Laboratory Data, in Appendix B.

TEST METHOD: ASTM D4318



KEY	EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	NATURAL MOISTURE CONTENT (PERCENT)	PERCENT PASSING NO. 40 SIEVE (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
●	B-5	S-1	2.5	25.6	NA	40	22	18

SUMMARY OF LABORATORY DATA

MUTUAL MATERIALS
CLACKAMAS, OREGON

PBS PROJECT NUMBER:
22847.001

SAMPLE INFORMATION				MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT (PERCENT)	PLASTIC LIMIT (PERCENT)	PLASTICITY INDEX (PERCENT)
B-1	S-1	2.5		26.4							
B-4	S-1	2.5		21.1							
B-4	S-2	5		24.4							
B-5	S-1	2.5		25.6					40	22	18
B-5	S-2	5		17.3				14			

__LAB SUMMARY 22847.001_B1-6_20190506.GPJ PBS_DATATMPL_GEO.GDT PRINT DATE: 5/29/19:RPG

FIGURE B2