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Geotechnical Investigation Report
SR-20 Pedestrian Walkway Project

Prepared for
City of Port Townsend

January 2018
SR-20 PEDESTRIAN WALKWAY PROJECT
CITY OF PORT TOWNSEND
GEOTECHNICAL INVESTIGATION REPORT

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1.0 INTRODUCTION

1.1 Purpose and Scope

This report presents the results of the geotechnical investigation performed on behalf of the City of Port Townsend for the State Route (SR)-20 Pedestrian Walkway Project per the requirements of the 2012, Washington State Department of Transportation (WSDOT) Geotechnical Design Manual. The goals of this study were to perform a subsurface exploration at the project site, provide geotechnical engineering findings and preliminary recommendations for the design and construction of the proposed infrastructure. This work was completed in accordance with the scope of work described in the professional services agreement dated June 29, 2016, between PND Engineers, Inc. and the City of Port Townsend. The services summarized in this report include the following:

- Research of previous geotechnical and geologic data available for the project vicinity;
- Exploration and characterization of subsurface conditions at the site;
- Geotechnical laboratory testing on selected soil samples obtained from the explorations;
- Developing geotechnical engineering design recommendations for the planned improvements; and
- Preparation of this report.

1.2 Project Description

The project is located in the right-of-way along SR-20, also known as Sims Way in the City of Port Townsend, Washington (Figure 1-1). We understand the project will consist of providing pedestrians and cyclists a code-compliant mixed-use travel-way from Logan Street to Hancock Street. This will necessitate a structure to cross or fill the ravine shown in red below, to provide room for the new pedestrian/cyclist travel-way.

Figure 1-1. Aerial Photo of the Project Site Location
2.0 SURFACE CONDITIONS AND USE

The project site spans about 900 feet along the south side of SR-20, between Logan Street and Hancock Street, crossing a ravine area at Bishop Park. A vicinity map and site plan are included in Appendix A. The existing site development includes the highway and bike lane with a sandy embankment, natural drainage, and a small dirt foot path along the shoulder with mowed grasses and thickly vegetated ravine of blackberry, and deciduous and coniferous trees. During the site exploration, the route was used by pedestrians and cyclists frequently throughout the day.

![Image 2-1. Project Site Ravine Crossing Location](image)

3.0 REGIONAL AND SITE GEOLOGY

3.1 Regional Geology

The landforms and near-surface deposits that cover much of the region reflect a relatively brief, recent period in the geologic history of at least seven Quaternary Period glaciations, with the most recent glacial retreat occurring some 14,000 years ago. During these glaciations, ice sheets covered the region. A review of the available geologic information for the project vicinity included U.S. Geological Service (USGS) Geologic Map GM 57 (Schasse and Slaughter, 2005). The most recent glacial event includes the Vashon Stade of the Fraser Glaciation. Sea level fluctuated significantly relative to the land surface and present day sea level, in response to the glacial advance and retreat (melting).

3.2 Site Geology

Based on Geologic Map GM 57 (Schasse and Slaughter, 2005), advance outwash sand and gravel buried the area during the Fraser Glaciation and then the ice arrived and covered the area under about 4,000 feet of ice. The native sand found immediately beneath the SR-20 road fill is likely part of this advance glacial outwash (Qga), consisting of very dense, poorly sorted sand. The depth to bedrock in the Port Townsend area is not well known, but is estimated at 500 to 2000+ feet deep.
4.0 REGIONAL AND SITE SEISMICITY

The site is in a seismically active area. The severity of ground shaking is primarily a function of the earthquake magnitude and proximity to the site. Accordingly, seismic hazards including liquefaction, lateral spreading, and fault rupture should be incorporated into the design as appropriate.

4.1 Regional Seismicity

Washington State has an estimated 2 percent of the annual United States earthquakes, with the Puget Sound region being the most tectonically active area within the state, containing numerous active faults. Seismicity in the region is attributed to three seismic zones, namely:

- Cascadia Subduction Zone interplate source zone – the result of the North American Plate overriding the subducting Juan de Fuca Plate. The interplate source zone is considered capable of producing a “megathrust” earthquake. The recurrence interval of an interplate earthquake event is thought to be on the order of 500 years.

- Cascadia Subduction Zone Benioff source zone – the result of deep differential motion within the Cascadia fault. Damaging Benioff earthquakes are thought to have a recurrence interval on the order of 30 years. The 2001 Nisqually Earthquake, centered south of the Seattle area, was the most recent significant Benioff earthquake event in the region, registering 6.8 on the Richter scale. Other recent Benioff events include the 1965 magnitude 6.5 Seattle and 1949 magnitude 7.1 Olympia earthquakes.

- Shallow crustal source zone – the result of compression of the Sierra Nevada block of the North American Plate. At least four magnitude 7 or greater earthquakes are thought to have occurred in the region within the past 1,100 years.

4.2 Site Seismicity

There are at least six “active” shallow crustal fault complexes with known or suspected Quaternary displacements within 10 miles of the project site, with the closest being the Southern Whidbey Island fault.

5.0 SITE DATA AVAILABLE

PND has been provided with a survey prepared by the City of Port Townsend. This information has been used for the analysis of the existing conditions and proposed development at the site. All elevations in this report are referenced to NAVD88 datum. There are no known existing historical borings in the area.

6.0 FIELD EXPLORATION

Between the dates of November 20 to 21, 2017, two boreholes were advanced to characterize the subsurface conditions on-site. Boreholes B-1 and B-2 were completed to depths of 50 and 80 feet below the existing ground surface, respectively. Borehole drilling and sampling was completed using equipment owned and operated by Cascade Drilling, Inc. under subcontract to PND. Appendix A includes a site plan depicting the approximate borehole locations.

The boreholes were advance using a Mobile B-59 truck-mounted drill-rig. Drilling techniques included rotary wash borings advanced with a 4-7/8-inch tricone bit. Boreholes were supported with bentonite slurry during drilling.

Drilling was continuously monitored by a PND Field Engineer who examined and classified the soil encountered, obtained representative samples, and prepared a detailed field log of each borehole. Each soil sample was visually classified in the field using a system based on the Unified Soil Classification System (USCS) and ASTM International visual classifications method per ASTM D 2488. Detailed logs of the boreholes are included in Appendix B which
presents pertinent data such as the sample locations, sampling methods, blow counts, and material (soil) descriptions. A soil consistency and symbols key is also included in Appendix B.

Soil samples were collected at 5-ft intervals from the boreholes using a standard 2-inch O.D. by 1.375-inch I.D. split-spoon sampler per ASTM D 1586. Samplers were driven into the undisturbed soil in advance of the borehole with a 140-pound automatic hammer falling 30 inches per blow. Uncorrected “field” blow counts are recorded on the borehole logs for each 6 inches of penetration required to advance the split spoon to a maximum depth of 18 inches for each sampling interval. Blow counts shown on the logs in Appendix B are uncorrected and have not been adjusted for overburden thickness, hammer efficiency, hammer type, drill rod length, or other drilling variables.

7.0 LABORATORY TESTING

Laboratory testing was performed on representative soil samples collected from the boreholes to evaluate pertinent physical characteristics of the soils and rock encountered at the site. The geotechnical laboratory program included tests for the determination of moisture content and grain-size distribution (sieve analysis) for the soil samples. Laboratory testing was performed by the HWA GeoSciences materials lab in Bothell, Washington, in general accordance with ASTM standard test methods. A description of the laboratory testing procedures and results are included in Appendix C.

Table 7-1. HWA Laboratory Results

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth</th>
<th>Sample</th>
<th>Classification</th>
<th>Gravel %</th>
<th>Sand %</th>
<th>Fines %</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>15.0’ - 21.5’</td>
<td>3/4</td>
<td>Dark gray, silty SAND (SM)</td>
<td>13.2</td>
<td>72.7</td>
<td>14.0</td>
</tr>
<tr>
<td>B2</td>
<td>75.0’ - 81.5’</td>
<td>12/13</td>
<td>Grayish brown, silty SAND (SM)</td>
<td>7.0</td>
<td>79.4</td>
<td>13.6</td>
</tr>
</tbody>
</table>

8.0 SUBSURFACE CONDITIONS

The boreholes completed for this geotechnical investigation were located on the shoulder of the road near the alignment of the proposed new pedestrian pathway. Generally, roadway embankment (fill) material overlying silty sands were encountered. Surficial deposits consisted of dense to very dense layers of sands. Ground conditions in this area included grassy area with topsoil. Native silty sands were encountered in both boreholes B-1 and B-2 at approximate depths of 30.0 and 35.0 feet, respectively. No fine grained soils were encountered in either B-1 or B-2. Groundwater was not measured in the boreholes as the bentonite drilling slurry precluded the ability to accurately measure groundwater. See Appendix B for logs for boreholes and tables below for a summary of the findings.

8.1 Borehole B-1

Table 8-1. Borehole B-1 Soil Profile

<table>
<thead>
<tr>
<th>Depth</th>
<th>Classification</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>0’ - 30’</td>
<td>Dark gray, silty SAND (SM)</td>
<td>Dense</td>
</tr>
<tr>
<td>30’ - 52’</td>
<td>Grayish brown, silty SAND (SM)</td>
<td>Very Dense</td>
</tr>
</tbody>
</table>

8.2 Borehole B-2

Table 8-2. Borehole B-2 Soil Profile

<table>
<thead>
<tr>
<th>Depth</th>
<th>Classification</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>0’ - 35’</td>
<td>Dark gray, silty SAND (SM)</td>
<td>Dense</td>
</tr>
<tr>
<td>35’ - 50’</td>
<td>Grayish brown, silty SAND (SM)</td>
<td>Very Dense</td>
</tr>
<tr>
<td>50’ - 70’</td>
<td>Grayish brown, silty SAND (SM)</td>
<td>Dense</td>
</tr>
<tr>
<td>70’ - 82’</td>
<td>Grayish brown, silty SAND (SM)</td>
<td>Very Dense</td>
</tr>
</tbody>
</table>
9.0 GEOLOGICAL HAZARDS

9.1 Seismic Hazards

The site was evaluated for seismic hazards including liquefaction and fault rupture. Based on the presence of the Southern Whidbey Island fault, which has been inferred to pass within the project vicinity, there is some risk of fault rupture. However, the last known rupture of this fault is approximately 1,000 years ago so the risk of surface rupture at the site is considered to be very low. The geotechnical exploration of the site encountered dense to very dense sand. An analysis based on information provided in these boreholes indicates no significant liquefaction potential.

9.2 Unstable Slopes Analysis

Seismic slope instability analysis is conducted to assess the impact of instability and slope deformation on structures (e.g., bridges, tunnels, and walls). Slopes that do not impact such structures are generally not mitigated for seismic slope instability. Based on the high soil densities encountered at the site in both the fill and underlying native materials, there is minimal potential for soil weakening or liquefaction during the seismic event, and therefore no resulting seismic slope instability.

10.0 GEOTECHNICAL RECOMMENDATIONS FOR EARTHWORK

10.1 Subgrade Preparation

We anticipate that little or no subgrade preparation will be required because embankment fill and native soils at the site were found to consist of dense to very dense sand containing about 15% fines. If encountered, any surface and subsurface deleterious material, organic matter, or debris should be removed from the planned areas of improvement. The exposed subgrade should be evaluated by a qualified geotechnical engineer after the site grading is complete (before the placement of structural fill) to identify and provide recommendations for improving unsuitable subgrade conditions. Evaluation methods used by the Geotechnical Engineer may include proof-rolling with heavy rubber tire construction equipment and/or probing. Soft, yielding, or otherwise unsuitable subgrade noted by the Geotechnical Engineer, which cannot be stabilized by additional compaction, should be excavated and replaced with structural fill (and covered as required) or mitigated by some other means as approved by the Geotechnical Engineer or Owner’s Representative.

10.2 Structural Fill

For the purpose of this report, structural fill refers to materials used to support foundations, structures, and pavements. The on-site soils generally do not meet the criteria for common borrow. The use of imported materials for structural fill should be planned for this project, especially for construction planned during periods of precipitation; however, on-site materials meeting the criteria for structural fill may be stockpiled and reused at the direction of the Geotechnical Engineer or Owner’s Representative.

Structural fill should be placed in 8-inch maximum loose lifts within 2 feet of the finished grades and/or structures and compacted to the specified densities. Maximum loose lift thicknesses of 12 inches may be used for structural fill placement below 2 feet from finished grades. In-place moisture and density testing frequency should be performed in accordance with WSDOT M41-01 Section 9-3.7 testing requirements on each lift to document suitable compaction has been achieved before the placement of the subsequent lift. Stockpiles of material to be used as structural fill should be covered to prevent saturation during wet weather. Large roller compaction equipment should maintain a minimum 5-foot setback from earth retaining structures during construction. Smaller compaction equipment and thinner loose lifts may be required to achieve adequate compaction within the 5-foot setback along walls.
Structural fill placed to support hardscapes or pavements should be compacted to at least 95 percent of the maximum Modified Proctor dry density (MDD) per ASTM D 1557 within 2 feet of final pavement subgrade; compaction of 90 percent MDD is required for structural fill below 24 inches of final pavement subgrade. Compaction of 95 percent MDD is required for full thickness of structural fill placed to support structures or foundations. Geotextile fabric should be placed over in-situ soils prior to the placement of structural fill material within the footprint hardscapes and slabs on grade to limit the potential for differential settlement.

The following material specifications are recommended for structural fill for the project:

- **Common Borrow 9-03.14(3)** WSDOT Standard Specification for dry weather structural fill placed to raise site grades, backfill utility trenches, and support structures, foundations, and pavements.
- **Gravel Borrow 9-03.14(1)** WSDOT Standard Specification for wet weather structural fill placed to raise site grades, backfill utility trenches, and support structures, foundations, and pavements.
- **Crushed Surfacing Base Course 9-03.9(3)** WSDOT Standard Specification for crushed surfacing base course below pavements.
- **Crushed Surfacing Course 9-03.9(3)** WSDOT Standard Specification for crushed surfacing top course below pavements.
- **Coarse Aggregate 9-03.1(4)C, grading No. 57** WSDOT Standard Specification for the 2-foot thickness of crushed rock below structural mat foundations and capillary break material (1½-inch minus clean crushed gravel with negligible sand or silt).
- **Gravel Backfill for Drains 9-03.12(4)** WSDOT Standard Specification for drain zone aggregate within 6 inches of foundation and wall drains.

### 10.3 Settlement Performance

Structures should be founded on dense undisturbed native deposits to limit the possibility of differential settlement. If the subgrade soils are loose or soft, it may be necessary to excavate the soils and replace them with structural fill or additional crushed rock material. If the subgrade soils are disturbed, the subgrade should be repaired as described in the earthwork section of the report. The over-excavation should thereafter be filled with structural fill material that is compacted to at least 95 percent of the maximum dry density (ASTM D 1557). Subgrade conditions should be observed and evaluated during construction to evaluate the presence of unsuitable subgrade soils and the need for over-excavation and/or additional mitigation measures based on the actual soils encountered.

### 11.0 GEOTECHNICAL RECOMMENDATIONS FOR STABILIZATION OF UNSTABLE SLOPES

All temporary cut slopes and shoring must comply with the provisions of Title 296 WAC, Part N, “Excavation, Trenching and Shoring”. The contractor performing the work has the primary responsibility for protection of workers and adjacent improvements. This responsibility includes determining need for shoring and establishing the safe inclination of temporary cut slopes. For planning purposes, permanent cut or fill slopes for the site should not be inclined steeper than 1.5H:1V (horizontal to vertical). Steeper slopes may be appropriate in special cases evaluated on a case-by-case basis. The existing road embankment, which has performed adequately for many years based on its state of mature vegetation growth, is approximately a 1.3H:1V side slope. Water should not be allowed to flow down cut slopes or fill slopes. Excess water at the top of cut/fill slopes should be directed to a suitable discharge point.
12.0 GEOTECHNICAL RECOMMENDATIONS FOR PAVEMENT AND OTHER STRUCTURES

12.1 Pavement

The following sections provide guideline recommendations pertaining to new pavements. The recommendations for subgrade preparation and various pavement sections are based on experience and thicker pavement sections may be warranted based on actual loading conditions and expected use.

12.1.1 Subgrade Preparation

PND recommends that the subgrade soils in new pavement areas be evaluated as described above in the “Site Preparation and Earthwork” section of this report. For new pavement areas, PND recommends that the upper 12 inches of the existing site soils be compacted to at least 95 percent of the MDD estimated in general accordance with ASTM D 1557 prior to placing pavement section materials. If the subgrade soils are loose or soft, it may be necessary to excavate the soils and replace them with structural fill. A layer of suitable woven geotextile fabric may be placed over soft subgrade areas to limit the thickness of structural fill required to bridge soft, yielding areas, as recommended by the geotechnical engineer. For pavement design, we recommend using a California Bearing Ratio (CBR) for subgrade soil of 15, which corresponds to an approximate resilient modulus ($M_r$) value of about 14,000 pounds per square inch (psi).

12.1.2 Hot Mix Asphalt Pavement (HMA) Sections

The minimum pavement section in traffic areas exposed only to pedestrian and/or light automobile traffic should consist of 2 inches of asphalt concrete over 6 inches of crushed surfacing base course. In areas subjected to highway traffic, the minimum pavement section should consist of a minimum of 6 inches of asphalt concrete over 12 inches of crushed surfacing base course. The base course should be compacted to at least 95 percent MDD estimated in general accordance with ASTM D 1557 and the base course thickness is in addition to the subgrade preparation depths presented above. Thicker asphalt sections may be needed based on the actual traffic data and intended use. For new HMA pavements, we recommend ½-inch HMA (PG 58-22) per Sections 5-04 and 9-03 of the WSDOT Standard Specifications.

12.1.3 Portland Cement Concrete (PCC) Sections

We recommend that PCC pavements for pedestrian loading consist of at least 4 inches of PCC over 6 inches of crushed surfacing base course. A thicker section may be needed based on the actual loading data. The base course should be compacted to at least 95 percent MDD estimated in general accordance with ASTM D 1557 and the base course thickness is in addition to the subgrade preparation depths presented above.

We recommend that PCC pavements incorporate construction joints and/or crack control joints that are spaced maximum distances of 12 feet apart, center-to-center, in both the longitudinal and transverse directions. Crack control joints may be created by placing an insert or groove into the fresh concrete surface during finishing, or by saw-cutting the concrete after its initial setup. We recommend that the depth of the crack control joints be approximately ¼ the thickness of the concrete, or about 1½ inches deep for the recommended concrete thickness of 6 inches. We also recommend that the crack control joints be sealed with an appropriate sealant to help reduce water infiltration into the joints. Full depth expansion joints should be provided every 20 feet and joints should be sealed with bituminous sealant. Dowel bars should be provided at 4 feet spacing between panels.
12.2 Pile Driving

During SPT sampling at borehole PND-2, blow counts of 100+ blows per foot were encountered at an approximate elevation of -35 feet. Vibratory pile driving may not be practical beyond this elevation and impacting pile driving will likely be required to achieve sufficient embedment depth. Bearing capacity calculations should incorporate blow count data contained in the borehole logs. An analysis of pile fixity in LPILE or similar should be conducted during the design to establish depth of embedment required to accommodate lateral loads.

12.3 MSE Retaining Wall

The design of an MSE retaining wall option should use the soil parameters listed in Table 13-1. For traffic loading, we recommend that walls be designed for a uniform surcharge pressure determined by increasing the height of the wall by 2 feet. Other surcharge loads should be included as appropriate. For design elements which include a buoyancy component we recommend that the groundwater table be assumed 10 feet above the bottom of the ravine.

Table 12-1. Recommended Design Parameters for MSE Retaining Wall Design

<table>
<thead>
<tr>
<th>Material</th>
<th>Elevation Range (ft)</th>
<th>Total Unit Weight (pcf)</th>
<th>Effective Friction Angle (°)</th>
<th>Cohesion (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Silty Sand (SP)</td>
<td>ALL</td>
<td>130</td>
<td>35</td>
<td>0</td>
</tr>
</tbody>
</table>

PND recommends that retaining wall systems be designed and constructed with drainage measures behind the walls to consist, at a minimum, of gravel backfill with a perforated drainpipe. All drainpipes should be tight-lined either to the storm drain system, day-lighted, or provided a free draining path, to prevent excess porewater pressure development behind the wall through some other means.

13.0 CLOSURE

The conclusions and recommendations submitted in this report are based on the field geotechnical investigation and laboratory testing conducted and other information described herein. The nature and extent of subsurface variations across the site may not become evident until construction. If conditions are encountered that appear to be different from those described herein, PND’s geotechnical engineer should be advised at once so re-evaluation of the conditions observed in this report based on the new information can be made.

PND is a member of the Geoprofessional Business Association (GBA). Included in Appendix E is a copy of the GBA publication “Important Information about This Geotechnical-Engineering Report” to help the Owner, Contractor, and others understand the limitations of this report.
14.0 REFERENCES


APPENDIX A

Figures: Vicinity Map, Site Plan, & Soil Profiles
APPENDIX B

Borehole Logs
SOILS CLASSIFICATION, CONSISTENCY AND SYMBOLS

CLASSIFICATION

Identification and classification of the soil is accomplished in general accordance with the ASTM version of the Unified Soil Classification System (USCS) as presented in ASTM Standard D2487. The standard is a qualitative method of classifying soil into the following major divisions (1) coarse grained, (2) fine grained, and (3) highly organic soils. Classification is performed on the soils passing the 75 mm (3 inch) sieve and if possible the amount of oversize material (> 75 mm particles) is noted on the soil logs. This is not always possible for drilled test holes because the oversize particles are typically too large to be captured in the sampling equipment. Oversize materials greater than 300 mm (12 inches) are termed boulders, while materials between 75 mm and 300 mm are termed cobbles. Coarse grained soils are those having 50% or more of the non-oversize soil retained on the No. 200 sieve (0.075 mm); if a greater percentage of the coarse grains is retained on the No. 4 (4.76 mm) sieve the coarse grained soil is classified as gravel, otherwise it is classified as sand. Fine grained soils are those having more than 50% of the non-oversize material passing the No. 200 sieve; these may be classified as silt or clay depending their Atterberg liquid and plastic limits or observations of field consistency. Refer to the most recent version of ASTM D2487 for a complete discussion of the classification method.

SOIL CONSISTENCY - CRITERIA

Soil consistency as defined below and determined by normal field and laboratory methods applies only to non-frozen material. For these materials, the influence of such factors as soil structure, i.e. Fissure systems, shrinkage cracks, slickensides, etc., must be taken into consideration in making any correlation with the consistency values listed below. In permafrost zones, the consistency and strength of frozen soils may vary significantly and unexplainably with ice content, thermal regime and soil type.

Standard Penetration Test (Blows/ft) Relative to Density/Consistency

<table>
<thead>
<tr>
<th>N&lt;sub&gt;60&lt;/sub&gt;</th>
<th>Density</th>
<th>Relative Density</th>
<th>N&lt;sub&gt;60&lt;/sub&gt;</th>
<th>Consistency</th>
<th>Undrained Shear Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4</td>
<td>Very Loose</td>
<td>0 - 15%</td>
<td>&lt; 2</td>
<td>Very Soft</td>
<td>&lt; 250</td>
</tr>
<tr>
<td>4 - 10</td>
<td>Loose</td>
<td>15 - 35%</td>
<td>2 - 4</td>
<td>Soft</td>
<td>250 - 500</td>
</tr>
<tr>
<td>10 - 30</td>
<td>Medium</td>
<td>35 - 65%</td>
<td>4 - 8</td>
<td>Medium</td>
<td>500 - 1000</td>
</tr>
<tr>
<td>30 - 50</td>
<td>Dense</td>
<td>65 - 85%</td>
<td>8 - 15</td>
<td>Stiff</td>
<td>1000 - 2000</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>Very Dense</td>
<td>&gt; 85%</td>
<td>15 - 30</td>
<td>Very Stiff</td>
<td>2000 - 4000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 30</td>
<td>Hard</td>
<td>&gt; 4000</td>
</tr>
</tbody>
</table>

ASTM D1586 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils
ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (USCS)

SAMPLER TYPE SYMBOLS

A Auger Sample                  Hs 1.4" Split Spoon w/ Air Hammer   Ss 1.4" Split Spoon w/ 140# Hammer
Bs Bulk (grab) Sample           Pb Pitcher Barrel                  St 1.4" Split Spoon w/ 47# Hammer
Cs Core Barrel w/ Single Tube  Sl 2.5" Split Spoon w/ 140# Hammer   Sx 2.0" Split Spoon w/ 47# Hammer
Cd Core Barrel w/ Double Tube  Sm 2.5" Split Spoon w/ 300# Hammer    Sz 1.4 Split Spoon w/ 340# Hammer
Ct Core Barrel w/ Triple Tube  Sh 2.5" Split Spoon w/ 340# Hammer    Ts Shelby Tube
Hl 2.5" Split Spoon w/ Air Hammer Sp 2.5" Split Spoon, Pushed   Tm Modified 2.5 O.D. Shelby Tube

Note: Split Spoon size refers to sampler inside diameter.

<table>
<thead>
<tr>
<th>Designed:</th>
<th>PND</th>
<th>Drawn:</th>
<th>PND</th>
<th>Checked:</th>
<th>PND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.:</td>
<td>154073</td>
<td>Date:</td>
<td>March 2016</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### COLUMN DESCRIPTIONS

1. **Depth**
   - Depth (in feet) below the ground surface.

2. **Water Level**
   - Groundwater level recorded while drilling. Depths and times are recorded in comments column.

3. **Graphic Log**
   - Graphic depiction of materials encountered.

4. **Soil Description**
   - Description of materials encountered, including USCS soil descriptions.

5. **Sample Number**
   - Sample identification number.

6. **Sample Type**
   - Type of soil sample collected at depth interval depicted; symbols explained on Fig. B-1.1.

7. **Sample Location**
   - Location soil sample taken.

8. **Sample Recovery**
   - Percentage of sample recovered.

9. **Sample Blows**
   - Number of blows to advance driven sampler each 6-inch interval using sampler type specified with a 30-inch drop. Blows per foot given in parentheses.

10. **Graphs**
    - Graphic log depicting blow counts per foot with a specified split spoon, Pocket Penetration and Vane Shear tests depicted where taken on fine grained soils.

11. **Comments**
    - Comments or observations on drilling/sampling by driller or PND field personnel.

12. **Elevation**
    - Elevation (in feet) with respect to Mean Lower Low Water (MLLW) or other datum where specified.

### GENERAL NOTES

1. Field descriptions may have been modified to reflect laboratory test results.

2. Descriptions on these boring logs apply only at the specific locations at the time the borings were drilled. They are not warranted to be representative of subsurface conditions at other locations or times.

3. Split spoon blow counts shown are uncorrected raw data. Various hammer sizes and split spoon sizes were used and have not been corrected to a Standard Penetration Test (SPT). Blow counts may vary substantially between SPT and these methods.
## Soil Legend

<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>SYMBOLS</th>
<th>TYPICAL DESCRIPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COARSE GRAINED SOILS</td>
<td>CLEAN GRAVELS</td>
<td>Well-graded gravels, gravel-sand mixtures, little or no fines</td>
</tr>
<tr>
<td></td>
<td>GRAVELS WITH FINES</td>
<td>Poorly graded gravels, gravel-sand mixtures, little or no fines</td>
</tr>
<tr>
<td></td>
<td>SANDS WITH FINES</td>
<td>Silty gravels, gravel-sand-clay mixtures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clayey gravels, gravel-sand-clay mixtures</td>
</tr>
<tr>
<td>FINE GRAINED SOILS</td>
<td>CLEAN SANDS</td>
<td>Well-graded sands, gravelly sands, little or no fines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poorly graded sands, gravelly sands, little or no fines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Silty sands, sand-silt mixtures</td>
</tr>
<tr>
<td></td>
<td>CLAYY SANDS</td>
<td>Clayey sands, sand-silt mixtures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Silty sands, sand-silt mixtures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organic silts and organic silty clays of low plasticity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inorganic clays, micaceous or diatomaceous fine sandy or silty soils, plastic silts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inorganic clays of high plasticity, lean clays</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organic clays of medium to high plasticity, organic silts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor and other highly organic soils</td>
</tr>
</tbody>
</table>

 NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

## Stratigraphic Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

## Laboratory / Field Tests List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>%F</td>
<td>Percent Fines</td>
</tr>
<tr>
<td>AL</td>
<td>Atterberg Limits</td>
</tr>
<tr>
<td>CP</td>
<td>Consolidation test</td>
</tr>
<tr>
<td>CO</td>
<td>Laboratory Compaction test</td>
</tr>
<tr>
<td>DP</td>
<td>Depth &quot;Peat&quot; Probe</td>
</tr>
<tr>
<td>DS</td>
<td>Direct Shear</td>
</tr>
<tr>
<td>HA</td>
<td>Hydrometer Analysis</td>
</tr>
<tr>
<td>LMA</td>
<td>Limited Mechanical Analysis</td>
</tr>
<tr>
<td>MC</td>
<td>Moisture Content</td>
</tr>
<tr>
<td>DD</td>
<td>Dry Density</td>
</tr>
<tr>
<td>OC</td>
<td>Organic Content</td>
</tr>
<tr>
<td>PM</td>
<td>Permeability or Hydraulic Conductivity</td>
</tr>
<tr>
<td>PP</td>
<td>Pocket Penetrometer</td>
</tr>
<tr>
<td>SA</td>
<td>Sieve Analysis</td>
</tr>
<tr>
<td>TV</td>
<td>Torvane</td>
</tr>
<tr>
<td>TX</td>
<td>Triaxial Shear</td>
</tr>
<tr>
<td>UC</td>
<td>Unconfined Compression</td>
</tr>
<tr>
<td>VS</td>
<td>Vane Shear</td>
</tr>
</tbody>
</table>

**Designed:** PND  
**Drawn:** PND  
**Checked:** PND  
**Project No.:** 154073  
**Date:** March 2016
Some gravel

Minimal gravel

Samples 3 and 4 combined for sufficient quantity for gradation test. 13.3% gravel, 72.7% sand, 14.0% fines.
Samples 3 and 4 combined for sufficient quantity for gradation test. 13.3% gravel, 72.7% sand, 14.0% fines.

*Final 54 blows in only 5"

Broken rock fragments, difficult driving
*Final 55 blows in only 4"

#### SOIL DESCRIPTION

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Water Table</th>
<th>Graphic Symbol</th>
<th>Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.0</td>
<td></td>
<td></td>
<td>SILTY SAND (SM) dark gray, moist, medium dense to dense, fine, subrounded sand</td>
</tr>
<tr>
<td>22.5</td>
<td></td>
<td></td>
<td>SILTY SAND (SM) grayish brown, moist, very dense, fine, subrounded sand</td>
</tr>
<tr>
<td>25.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.0</td>
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<tr>
<td>37.5</td>
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<tr>
<td>40.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### SAMPLES

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Location</th>
<th>Recovery (%)</th>
<th>Penetration Blows per 6/Inch (per foot)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Ss</td>
<td>80</td>
<td></td>
<td>29-36-47 (83)</td>
</tr>
<tr>
<td>5</td>
<td>Ss</td>
<td>60</td>
<td></td>
<td>29-37-51 (88)</td>
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<td>6</td>
<td>Ss</td>
<td>50</td>
<td></td>
<td>35-41-54 (95)*</td>
</tr>
<tr>
<td>7</td>
<td>Ss</td>
<td>50</td>
<td></td>
<td>32-42-55 (97)*</td>
</tr>
</tbody>
</table>

#### GRAPH

- **BLOW COUNT**
  - 20
  - 40
  - 60
  - 80
- **POCKET PEN (tsf)**
  - 1
  - 2
  - 3
  - 4
- **VANE SHEAR (tsf)**
  - 0.2
  - 0.4
  - 0.6
  - 0.8

#### COMMENTS

Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information

Samples 3 and 4 combined for sufficient quantity for gradation test. 13.3% gravel, 72.7% sand, 14.0% fines.

#### BOREHOLE LOG SR20 PEDESTRIAN WALKWAY

City Of Port Townsend
Port Townsend, Washington

BoREHOLE B-1

FIGURE B-2.2

Logged By: MMO
Data Entry: CK
Checked: SR
Project No.: 164040
Date: 11/20/2017
Broken rock fragments, difficult driving
*12-18" blow counts not taken because 50 blows per 6" (refusal) reached

Hit rock and jammed drill bit.

*6-12" and 12-18" blow counts not taken because 50 blows per 6" (refusal) reached

No water table encountered. Terminated at: 51.5 ft, 11/20/2017

Silty Sand (SM) grayish brown, moist, very dense, fine, subrounded sand

*12-18" blow counts not taken because 50 blows per 6" (refusal) reached

SR 20 PEDESTRIAN WALKWAY
City Of Port Townsend
Port Townsend, Washington

BOREHOLE B-1
FIGURE B-2.3
<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Water Table</th>
<th>Graphic Symbol</th>
<th>Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information</th>
<th>Number</th>
<th>Type</th>
<th>Location</th>
<th>Recovery (%)</th>
<th>Penetration Blows per 6/Inch (per foot)*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td></td>
<td>SILTY SAND (SM) dark gray, moist, dense, fine, subrounded sand</td>
<td>1</td>
<td>Ss</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOIL DESCRIPTION**
- Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information

**SAMPLES**
- Number
- Type
- Location
- Recovery (%)
- Penetration Blows per 6/Inch (per foot)*

**GRAPH**
- BLOW COUNT
- POCKET PEN (tsf)
- VANE SHEAR (tsf)

**COMMENTS**
- Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information

**Start:** 11/20/2017

**SR 20 PEDESTRIAN WALKWAY**
City Of Port Townsend
Port Townsend, Washington

**BOREHOLE B-2**

**FIGURE B-3.1**
<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Water Table</th>
<th>Graphic Symbol</th>
<th>Soil Description</th>
<th>Penetration Blows per 6/Inch (per foot)*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.0</td>
<td></td>
<td></td>
<td>SILTY SAND (SM)</td>
<td>23-38-50 (88)</td>
<td>Minimal gravel</td>
</tr>
<tr>
<td>22.5</td>
<td></td>
<td></td>
<td>Dark gray, moist, dense, fine, subrounded sand</td>
<td>32-47-50 (97)*</td>
<td>Some gravel</td>
</tr>
<tr>
<td>25.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.5</td>
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<td></td>
<td></td>
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<tr>
<td>30.0</td>
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<tr>
<td>32.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.0</td>
<td></td>
<td></td>
<td>SILTY SAND (SM)</td>
<td>50 (100)*</td>
<td>*50 blows in only 5&quot;. 6-12&quot; and 12-18&quot; blow counts not taken because 50 blows per 6&quot; (refusal) reached</td>
</tr>
<tr>
<td>37.5</td>
<td></td>
<td></td>
<td>Grayish brown, moist, very dense, fine, subrounded sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**SOIL DESCRIPTION**

**Sample 1:**
- **Soil Name:** Silty Sand (SM)
- **Color:** Grayish brown
- **Moisture:** Moist
- **Density:** Very Dense
- **Texture:** Fine
- **Shape:** Subrounded sand

**Sample 2:**
- **Soil Name:** Silty Sand (SM)
- **Color:** Grayish brown
- **Moisture:** Moist
- **Density:** Dense
- **Texture:** Fine
- **Shape:** Subrounded sand

**Sample 3:**
- **Soil Name:** Silty Sand (SM)
- **Color:** Grayish brown
- **Moisture:** Moist
- **Density:** Dense
- **Texture:** Fine
- **Shape:** Subrounded sand

**Penetration Blows per 6/Inch (per foot)*:**
- **Sample 1:** 43-46-56 (100+)
- **Sample 2:** 35-50 (85)*
- **Sample 3:** 41-44-47 (91)

**Additional Information:**
- *Final 50 blows in only 5"*
- 12-18" blow counts not taken because 50 blows per 6" (refusal) reached
- Some gravel at bottom of sample
- Some medium coarse sand

---

**Borehole Log:** BOREHOLE LOG SR20 PEDESTRIAN WALKWAY ©2017

**Additional Information:**
- **Logged By:** MMO
- **Data Entry:** CK
- **Checked:** SR
- **Project No.:** 164040
- **Date:** 11/20/2017

**SR 20 PEDESTRIAN WALKWAY**
City Of Port Townsend
Port Townsend, Washington

**Borehole B-2**
**Figure B-3.3**
Samples 12 and 13 combined for sufficient quantity for gradation test. 7.0% gravel, 79.4% sand, 13.6% fines.

**Final 50 blows in only 5.5".**

12-18" blow counts not taken because 50 blows per 6" (refusal) reached.

No water table encountered.

Terminated at: 81.5 ft, 11/21/2017

**Silty Sand (SM)**

Grayish brown, moist, dense to very dense, fine, subrounded sand.

Date: 11/20/2017
APPENDIX C

Geotechnical Laboratory Testing
December 5, 2017
HWA Project No. 2012-032-23 Task 1100

PND Engineers, Inc.
1736 Fourth Avenue S, Suite A
Seattle, Washington 98134

Attention: Ms. Megan O'Connor, P.E.

Subject: Materials Laboratory Report
Soil Index Testing
SR 20 Project

Dear Ms. O'Connor;

In accordance with your request, HWA GeoSciences Inc. (HWA) performed laboratory testing for the above referenced project. Herein we present the results of our laboratory analyses, which are summarized on the attached report. The laboratory testing program was performed in general accordance with your instructions and appropriate ASTM Standards as outlined below.

**Sample Description:** The subject samples were delivered to our laboratory on December 1, 2017 by Courier. The samples were delivered in re-sealable plastic bags and were designated with exploration ID, sample number, and depth of sampling. The soil samples were classified using visual-manual methods as follows:

- B1, 3/4 — Dark gray, silty SAND (SM)
- B2, 12/13 — Grayish-brown, silty SAND (SM)

**Moisture Content of Soil:** The moisture contents of the soil samples (percent by dry mass) were determined in general accordance with ASTM D2216. The results are shown on Figure 1.

**Particle Size Analysis of Soils:** The particle size distribution of each specified sample was determined in general accordance with ASTM D422, using sieve analysis only. The results are plotted on the attached Particle Size Analysis of Soil Report, Figure 1, which also indicates the moisture content of the soil samples at the time of testing.
CLOSURE: Experience has shown that test values on soil and other natural materials vary with each representative sample. As such, HWA has no knowledge as to the extent and quantity of material the tested samples may represent. HWA also makes no warranty as to how representative either the samples tested or the test results obtained are to actual field conditions. It is a well-established fact that sampling methods present varying degrees of disturbance that affect sample representativeness.

No copy should be made of this report except in its entirety.

We appreciate the opportunity to provide laboratory testing services on this project. Should you have any questions or comments, or if we may be of further service, please call.

HWA GeoSciences Inc.

Stephen Wright
Materials Laboratory Manager

Steven E. Greene, L.G., L.E.G.
Principal Engineering Geologist
Vice President

Attachments:

Figure 1  Particle Size Analysis of Soils
### Particlesize Analysis of Soils

**Method ASTM D422**

#### U.S. Standard Sieve Sizes

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE</th>
<th>DEPTH (ft)</th>
<th>Classification of Soil - ASTM D2487 Group Symbol and Name</th>
<th>% MC</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Gravel</th>
<th>Sand</th>
<th>Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B1</td>
<td>3/4</td>
<td>15.0 - 21.5 (SM) Dark gray, silty SAND</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td>13.3</td>
<td>72.7</td>
<td>14.0</td>
</tr>
<tr>
<td></td>
<td>B2</td>
<td>12/13</td>
<td>75.0 - 81.5 (SM) Dark gray, silty SAND</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td>7.0</td>
<td>79.4</td>
<td>13.6</td>
</tr>
</tbody>
</table>

**Laboratory Testing for PND Engineers**

SR 20 Project
APPENDIX D
Field Photographs
Foremost Mobile B-59 Drill Rig.

Borehole B-1.

Borehole B-2 (Previously B-3).

Samples were collected with standard sampler.
APPENDIX E

Important Information about your Geotechnical Engineering Report
The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a public-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared solely for the client. Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled. No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it in its entirety. Do not rely on an executive summary. Do not read selected elements only. Read this report in full.

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. If your geotechnical engineer has not indicated an “apply-by” date on the report, ask what it should be, and, in general, if you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.
This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations only after observing actual subsurface conditions revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals’ plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, but be certain to note conspicuously that you’ve included the material for informational purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, only from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and be sure to allow enough time to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated subsurface environmental problems have led to project failures. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer’s services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. Geotechnical engineers are not building-envelope or mold specialists.
Providing Comprehensive Civil/Structural Services Since 1979
December 5, 2017
HWA Project No. 2012-032-23 Task 1100

PND Engineers, Inc.
1736 Fourth Avenue S, Suite A
Seattle, Washington 98134

Attention: Ms. Megan O’Connor, P.E.

Subject: Materials Laboratory Report
Soil Index Testing
SR 20 Project

Dear Ms. O’Connor;

In accordance with your request, HWA GeoSciences Inc. (HWA) performed laboratory testing for the above referenced project. Herein we present the results of our laboratory analyses, which are summarized on the attached report. The laboratory testing program was performed in general accordance with your instructions and appropriate ASTM Standards as outlined below.

**SAMPLE DESCRIPTION:** The subject samples were delivered to our laboratory on December 1, 2017 by Courier. The samples were delivered in re-sealable plastic bags and were designated with exploration ID, sample number, and depth of sampling. The soil samples were classified using visual-manual methods as follows:

- B1, 3/4 — Dark gray, silty SAND (SM)
- B2, 12/13 — Grayish-brown, silty SAND (SM)

**MOISTURE CONTENT OF SOIL:** The moisture contents of the soil samples (percent by dry mass) were determined in general accordance with ASTM D 2216. The results are shown on Figure 1.

**PARTICLE SIZE ANALYSIS OF SOILS:** The particle size distribution of each specified sample was determined in general accordance with ASTM D422, using sieve analysis only. The results are plotted on the attached Particle Size Analysis of Soil Report, Figure 1, which also indicates the moisture content of the soil samples at the time of testing.
CLOSURE: Experience has shown that test values on soil and other natural materials vary with each representative sample. As such, HWA has no knowledge as to the extent and quantity of material the tested samples may represent. HWA also makes no warranty as to how representative either the samples tested or the test results obtained are to actual field conditions. It is a well-established fact that sampling methods present varying degrees of disturbance that affect sample representativeness.

No copy should be made of this report except in its entirety.

We appreciate the opportunity to provide laboratory testing services on this project. Should you have any questions or comments, or if we may be of further service, please call.

HWA GeoSciences Inc.

[Signatures]

Stephen Wright
Materials Laboratory Manager

Steven E. Greene, L.G., L.E.G.
Principal Engineering Geologist
Vice President

Attachments:

Figure 1  Particle Size Analysis of Soils
PARTICLE-SIZE ANALYSIS OF SOILS
METHOD ASTM D422

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE</th>
<th>DEPTH (ft)</th>
<th>CLASSIFICATION OF SOIL- ASTM D2487 Group Symbol and Name</th>
<th>% MC</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Gravel %</th>
<th>Sand %</th>
<th>Fines %</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>B1</td>
<td>3/4</td>
<td>15.0 - 21.5 (SM) Dark gray, silty SAND</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td>13.3</td>
<td>72.7</td>
<td>14.0</td>
</tr>
<tr>
<td>■</td>
<td>B2</td>
<td>12/13</td>
<td>75.0 - 81.5 (SM) Dark gray, silty SAND</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td>7.0</td>
<td>79.4</td>
<td>13.6</td>
</tr>
</tbody>
</table>
SOILS CLASSIFICATION, CONSISTENCY AND SYMBOLS

CLASSIFICATION

Identification and classification of the soil is accomplished in general accordance with the ASTM version of the Unified Soil Classification System (USCS) as presented in ASTM Standard D2487. The standard is a qualitative method of classifying soil into the following major divisions (1) coarse grained, (2) fine grained, and (3) highly organic soils. Classification is performed on the soils passing the 75 mm (3 inch) sieve and if possible the amount of oversize material (> 75 mm particles) is noted on the soil logs. This is not always possible for drilled test holes because the oversize particles are typically too large to be captured in the sampling equipment. Oversize materials greater than 300 mm (12 inches) are termed boulders, while materials between 75 mm and 300 mm are termed cobbles. Coarse grained soils are those having over 50% or more of the non-oversize soil retained on the No. 200 sieve (0.075 mm); if a greater percentage of the coarse grains is retained on the No. 4 (4.76 mm) sieve the coarse grained soil is classified as gravel, otherwise it is classified as sand. Fine grained soils are those having more than 50% of the non-oversize material passing the No. 200 sieve; these may be classified as silt or clay depending on their Atterberg liquid and plastic limits or observations of field consistency. Refer to the most recent version of ASTM D2487 for a complete discussion of the classification method.

SOIL CONSISTENCY - CRITERIA

Soil consistency as defined below and determined by normal field and laboratory methods applies only to non-frozen material. For these materials, the influence of such factors as soil structure, i.e. Fissure systems, shrinkage cracks, slickensides, etc., must be taken into consideration in making any correlation with the consistency values listed below. In permafrost zones, the consistency and strength of frozen soils may vary significantly and unexplainably with ice content, thermal regime and soil type.

Standard Penetration Test (Blows/ft) Relative to Density/Consistency

<table>
<thead>
<tr>
<th>N_60</th>
<th>Density</th>
<th>Relative Density</th>
<th>N_60</th>
<th>Consistency</th>
<th>Undrained Shear Strength (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4</td>
<td>Very Loose</td>
<td>0 - 15%</td>
<td>&lt; 2</td>
<td>Very Soft</td>
<td>&lt; 250</td>
</tr>
<tr>
<td>4 - 10</td>
<td>Loose</td>
<td>15 - 35%</td>
<td>2 - 4</td>
<td>Soft</td>
<td>250 - 500</td>
</tr>
<tr>
<td>10 - 30</td>
<td>Medium</td>
<td>35 - 65%</td>
<td>4 - 8</td>
<td>Medium</td>
<td>500 - 1000</td>
</tr>
<tr>
<td>30 - 50</td>
<td>Dense</td>
<td>65 - 85%</td>
<td>8 - 15</td>
<td>Stiff</td>
<td>1000 - 2000</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>Very Dense</td>
<td>&gt; 85%</td>
<td>15 - 30</td>
<td>Very Stiff</td>
<td>2000 - 4000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 30</td>
<td>Hard</td>
<td>&gt; 4000</td>
</tr>
</tbody>
</table>

ASTM D1586 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils
ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (USCS)

SAMPLER TYPE SYMBOLS

| A | Auger Sample | Hs | 1.4" Split Spoon w/ Air Hammer | Ss | 1.4" Split Spoon w/ 140# Hammer |
| Bs | Bulk (grab) Sample | Pb | Pitcher Barrel | St | 1.4" Split Spoon w/ 47# Hammer |
| Cs | Core Barrel w/ Single Tube | Sl | 2.5" Split Spoon w/ 140# Hammer | Ss | 2.0" Split Spoon w/ 47# Hammer |
| Cd | Core Barrel w/ Double Tube | Sq | 2.5" Split Spoon w/ 300# Hammer | Sz | 1.4 Split Spoon w/ 340# Hammer |
| Ct | Core Barrel w/ Triple Tube | Sh | 2.5" Split Spoon w/ 340# Hammer | Ts | Shelby Tube |
| Hl | 2.5" Split Spoon w/ Air Hammer | Sp | 2.5" Split Spoon, Pushed | Tm | Modified 2.5 O.D. Shelby Tube |

Note: Split Spoon size refers to sampler inside diameter.
<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Graphic Symbol</th>
<th>Soil Description</th>
<th>Samples</th>
<th>Graph</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0' - 0.30' A.C. PAVEMENT</td>
<td>POORLY-GRADED GRAVEL W/ SILT AND SAND (GP-GM) Gray, Moist, Dense, Subangular</td>
<td>Number: 1, Type: Ss, Recovery: 30 [20-20.25 (65)]</td>
<td>Penetration Blows per 6/Inch (per Foot)*</td>
<td>Begin drilling 10/24/03 8:00 a.m. 2' to 3' - Hard, load drilling (Cobbles/Boulder encountered)</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### COLUMN DESCRIPTIONS

1. **Depth**: Depth (in feet) below the ground surface.
2. **Water Level**: Groundwater level recorded while drilling. Depths and times are recorded in comments column.
3. **Graphic Log**: Graphic depiction of materials encountered.
4. **Soil Description**: Description of materials encountered, including USCS soil descriptions.
5. **Sample Number**: Sample identification number.
6. **Sample Type**: Type of soil sample collected at depth interval depicted; symbols explained on Fig. B-1.1.
7. **Sample Location**: Location soil sample taken.
8. **Sample Recovery**: Percentage of sample recovered.
9. **Sample Blows**: Number of blows to advance driven sampler each 6-inch interval using sampler type specified with a 30-inch drop. Blows per foot given in parentheses.
10. **Graphs**: Graphic log depicting blow counts per foot with a specified split spoon, Pocket Penetration and Vane Shear tests depicted where taken on fine grained soils.
11. **Comments**: Comments or observations on drilling/sampling by driller or PND field personnel.
12. **Elevation**: Elevation (in feet) with respect to Mean Lower Low Water (MLLW) or other datum where specified.

### GENERAL NOTES

1. Field descriptions may have been modified to reflect laboratory test results.
2. Descriptions on these boring logs apply only at the specific locations at the time the borings were drilled. They are not warranted to be representative of subsurface conditions at other locations or times.
3. Split spoon blow counts shown are uncorrected raw data. Various hammer sizes and split spoon sizes were used and have not been corrected to a Standard Penetration Test (SPT). Blow counts may vary substantially between SPT and these methods.
### Soil Legend

<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>SYMBOLS</th>
<th>TYPICAL DESCRIPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRAVEL AND GRAVELLY SOILS</td>
<td>CLEAN GRAVELS</td>
<td>Well-graded gravels, gravel-sand mixtures, little or no fines</td>
</tr>
<tr>
<td>MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE (4.75mm)</td>
<td>GRAVELS WITH FINES</td>
<td>Poorly graded gravels, gravel-sand mixtures, little or no fines</td>
</tr>
<tr>
<td>SAND AND SANDY SOILS</td>
<td>CLEAN SANDS</td>
<td>Silty gravels, gravel-sand-silt mixtures</td>
</tr>
<tr>
<td>MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE (4.75mm)</td>
<td>SANDS WITH FINES</td>
<td>Clayey gravels, gravel-sand-clay mixtures</td>
</tr>
<tr>
<td>FINE GRAINED SOILS</td>
<td>SILTS AND CLAYS</td>
<td>Highly organic soils</td>
</tr>
<tr>
<td>LIQUID LIMIT LESS THAN 35</td>
<td>ML</td>
<td>Inorganic silts and very fine sands, some fine sand, fine or medium plasticity, silty or clayey fine sands or clayey silt with slight plasticity</td>
</tr>
<tr>
<td>CL</td>
<td>Inorganic silts and organic silts of low plasticity</td>
<td></td>
</tr>
<tr>
<td>OL</td>
<td>Organic silt and organic silty clays of low plasticity</td>
<td></td>
</tr>
<tr>
<td>MH</td>
<td>Inorganic silts, claylike or discontinuous fine sands or silty silt, plastic silt</td>
<td></td>
</tr>
<tr>
<td>CH</td>
<td>Inorganic clays of high plasticity, lean clays</td>
<td></td>
</tr>
<tr>
<td>OH</td>
<td>Organic clays of medium to high plasticity, organic silt</td>
<td></td>
</tr>
<tr>
<td>PT</td>
<td>Poor and other highly organic soils</td>
<td></td>
</tr>
</tbody>
</table>

---

### Stratigraphic Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

### Laboratory / Field Tests List of Abbreviations

- %F: Percent Fines
- AL: Atterberg Limits
- CP: Laboratory Compaction test
- CO: Consolidation test
- DP: Depth "Peat" Probe
- DS: Direct Shear
- HA: Hydrometer Analysis
- LMA: Limited Mechanical Analysis
- MC: Moisture Content
- DD: Dry Density
- OC: Organic Content
- PM: Permeability or Hydraulic Conductivity
- PP: Pocket Penetrometer
- SA: Sieve Analysis
- TV: Torvane
- TX: Triaxial Shear
- UC: Unconfined Compression
- VS: Vane Shear

---

**ENGINEERS, INC.**

**STANDARD BOREHOLE LOG DETAILS**

**BOREHOLE LOGS**

**FIGURE B-1.3**

**DESIGNED:** PND  
**DRAWN:** PND  
**CHECKED:** PND  
**PROJECT NO.:** 154073  
**DATE:** March 2016
Some gravel

Minimal gravel

Samples 3 and 4 combined for sufficient quantity for gradation test. 13.3% gravel, 72.7% sand, 14.0% fines.
Samples 3 and 4 combined for sufficient quantity for gradation test. 13.3% gravel, 72.7% sand, 14.0% fines.

*Final 54 blows in only 5"

Broken rock fragments, difficult driving
*Final 55 blows in only 4"

SILTY SAND (SM)
dark gray, moist, medium dense to dense, fine, subrounded sand

SILTY SAND (SM)
grayish brown, moist, very dense, fine, subrounded sand

Breaking rock fragments, difficult driving
*Final 55 blows in only 4"

Samples 3 and 4 combined for sufficient quantity for gradation test. 13.3% gravel, 72.7% sand, 14.0% fines.
Broken rock fragments, difficult driving

*12-18" blow counts not taken because 50 blows per 6" (refusal) reached

Hit rock and jammed drill bit.

*6-12" and 12-18" blow counts not taken because 50 blows per 6" (refusal) reached

No water table encountered. Terminated at: 51.5 ft, 11/20/2017

---

SOIL DESCRIPTION

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Graphic Symbol</th>
<th>Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>40.0</td>
<td></td>
<td>SILTY SAND (SM) grayish brown, moist, very dense, fine, subrounded sand</td>
</tr>
<tr>
<td>42.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SAMPLES

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Location</th>
<th>Recovery (%)</th>
<th>Penetration Blows per 6/Inch (per foot)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Ss</td>
<td>30</td>
<td>42-53 (95)*</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Ss</td>
<td>10</td>
<td>50 (100)*</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Ss</td>
<td>30</td>
<td>49-50 (99)*</td>
<td></td>
</tr>
</tbody>
</table>

GRAPH

- BLOW COUNT
- POCKET PEN (tsf)
- VANE SHEAR (tsf)

COMMENTS

Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information

Date: 11/20/2017

---

SR 20 PEDESTRIAN WALKWAY
City Of Port Townsend
Port Townsend, Washington

BOREHOLE B-1
FIGURE B-2.3
SOIL DESCRIPTION

- Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Water Table</th>
<th>Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td>SILTY SAND (SM) dark gray, moist, dense, fine, subrounded sand</td>
</tr>
</tbody>
</table>

SAMPLES

- Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Location</th>
<th>Recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ss</td>
<td>90</td>
<td>27-43-51 (94)</td>
</tr>
</tbody>
</table>

GRAPH

- BLOW COUNT
- POCKET PEN (tsf)
- VANE SHEAR (tsf)

- Minimal gravel

COMMENTS

- Start: 11/20/2017

Project No.: 164040

SR 20 PEDESTRIAN WALKWAY
City Of Port Townsend
Port Townsend, Washington

BOREHOLE B-2 | FIGURE B-3.1
### Soil Description

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.0</td>
<td>SILTY SAND (SM) dark gray, moist, dense, fine, subrounded sand</td>
</tr>
<tr>
<td>22.5</td>
<td>SILTY SAND (SM) grayish brown, moist, very dense, fine, subrounded sand</td>
</tr>
</tbody>
</table>

### Samples

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Location</th>
<th>Recovery (%)</th>
<th>Penetration Blows per 6/Inch (per foot)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Ss</td>
<td>60</td>
<td>23-38-50</td>
<td>(88)</td>
</tr>
<tr>
<td>3</td>
<td>Ss</td>
<td>60</td>
<td>32-47-50</td>
<td>(97)*</td>
</tr>
<tr>
<td>4</td>
<td>Ss</td>
<td>20</td>
<td>50</td>
<td>(100)*</td>
</tr>
</tbody>
</table>

*Final 50 blows in only 4"

### Graph

- Minimal gravel
- Some gravel
- *50 blows in only 5", 6-12" and 12-18" blow counts not taken because 50 blows per 6" (refusal) reached

### Comments

Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information

---

SR 20 PEDESTRIAN WALKWAY
City Of Port Townsend
Port Townsend, Washington

BOREHOLE B-2
FIGURE B-3.2

Logged By: MMO
Data Entry: CK
Checked: SR
Project No.: 164040
Date: 11/20/2017
Some gravel at bottom of sample
*Final 50 blows in only 5".  12-18" blow counts not taken because 50 blows per 6" (refusal) reached

Some medium coarse sand
<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Water Table</th>
<th>Graphic Symbol</th>
<th>Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information</th>
<th>Number</th>
<th>Type</th>
<th>Location</th>
<th>Recovery (%)</th>
<th>Penetration Blows per 6/Inch (per foot)*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.0</td>
<td></td>
<td></td>
<td>SILTY SAND (SM) grayish brown, moist, dense, fine, subrounded sand</td>
<td>9</td>
<td>Ss</td>
<td>50</td>
<td></td>
<td>36-32-38 (70)</td>
<td></td>
</tr>
<tr>
<td>62.5</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>Ss</td>
<td>50</td>
<td></td>
<td>35-44-50 (94)*</td>
<td>*Final 50 blows in only 5”</td>
</tr>
<tr>
<td>65.0</td>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>Ss</td>
<td>40</td>
<td></td>
<td>35-50 (85)*</td>
<td>*Final 50 blows in only 5”, 12-18” blow counts not taken because 50 blows per 6” (refusal) reached</td>
</tr>
<tr>
<td>67.5</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>Ss</td>
<td>70</td>
<td></td>
<td>46-45-46 (91)</td>
<td>Samples 12 and 13 combined for sufficient quantity for gradation test. 7.0% gravel, 79.4% sand, 13.6% fines.</td>
</tr>
</tbody>
</table>
**SOIL DESCRIPTION**

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>80.0</td>
<td>SILTY SAND (SM) grayish brown, moist, dense to very dense, fine, subrounded sand</td>
</tr>
</tbody>
</table>

**SAMPLES**

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Ss</td>
<td>40</td>
</tr>
</tbody>
</table>

**Penetration Blows per 6/Inch (per foot)**

- 33.50 (83)*

**Graph**

- BLOW COUNT
- POCKET PEN (tsf)
- VANE SHEAR (tsf)

**Comments**

- Samples 12 and 13 combined for sufficient quantity for gradation test. 7.0% gravel, 79.4% sand, 13.6% fines.
- *Final 50 blows in only 5.5''. 12-18'' blow counts not taken because 50 blows per 6'' (refusal) reached.
- No water table encountered. Terminated at 81.5 ft, 11/21/2017.