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PRELIMINARY GEOTECHNICAL REPORT

Tukwila Elementary School Renovations and Modulars

TUKWILA, WASHINGTON

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

August 27, 2018

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Tukwila Elementary School
Renovations and Modulars
Tukwila, Washington

Preliminary Geotechnical Report

Shannon & Wilson participated in this project as a consultant to Tukwila School District and KMB Architects. Our scope of services was authorized by Tukwila School District Purchase Order Number 2031718053 dated July 30, 2018.

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ACRONYMS

bgs	below ground surface
Ecology	Washington State Department of Ecology
IBC	International Building Code
pcf	pounds per cubic foot
PGA	peak ground acceleration
PIT	pilot infiltration pit
psf	pounds per square inch
Qvrl	Quaternary recessional lacustrine deposits
Qvt	Quaternary Vashon till
Tpr	Tertiary Renton Formation
WSDOT	Washington State Department of Transportation
WWSWMM	Western Washington Stormwater Management Manual

1 SITE AND PROJECT DESCRIPTION

We understand that the Tukwila School District plans to perform renovations and construct modular unit additions at the existing Tukwila Elementary School property. Tukwila Elementary School is located south of South 149th Street between 59th Avenue South and 62nd Avenue South in Tukwila, Washington, as shown on the Vicinity Map (Figure 1). The renovations will consist of expanding the existing parking lot and bus loop to accommodate more vehicles and school buses. The District also plans to add two modular units south and southwest of the existing playground area to provide additional classrooms.

The purpose of this study is to perform a preliminary evaluation of the subsurface conditions to help facilitate the site selection and conceptual design process. Our scope of services included excavating six test pits around the property to evaluate the soil conditions and perform a pilot infiltration test (PIT) to evaluate stormwater infiltration rates. Laboratory testing was performed to determine the water content and grain size distribution or plasticity of representative soil samples from the parking lot, bus loop, and two modular unit locations. Authorization to perform this work was provided by KMB Architects with a signed proposal submitted on July 23, 2018.

This report presents the preliminary geotechnical engineering findings at the site. We have included our recommendations regarding infiltration, foundations, seismic design, lateral earth pressures, earthwork, and construction considerations in this report.

2 SITE CONDITIONS

2.1 Regional Geology

The site is located in Tukwila, Washington, which is within a region known as the Puget Lowland. The Puget Lowland is a structural depression bordered by the Olympic and Cascade Mountain ranges that is generally within about 500 feet of sea level. The geology of the area has been influenced by repeated cycles of glaciation, which worked to fill the lowland to significant depths with a complex sequence of glacial and nonglacial deposits. The most recent glacier to impact the area, the Vashon Stade of the Fraser Glaciation, overrode the area with up to 3,000 feet of ice in some locations.

The mapped geology indicates that the project site is underlain by Quaternary Vashon till (Qvt) and Tertiary Renton Formation (Tpr) bedrock of Eocene age. The Qvt unit is characterized by dense to very dense sands and gravels with variable amounts of silt, and cobble- to boulder-size material is common within this unit. The Tpr unit consists of sandstone as well as some siltstone, sandy shale, coal, and carbonaceous shale. The bedrock is mostly light gray but oxidizes to light brown to pale orange-brown. Sandstone of the Renton formation is typically weakly cemented and massive (Booth and Waldron, 2004).

Quaternary recessional lacustrine deposits (Qvrl) are located south and west of the project site. The Qvrl unit consists of very fine-grained sand, silt, and clay. Soils within this unit were deposited in small lakes during the ice recession and are typically not overconsolidated like the Qvt unit (Booth and Waldron, 2004).

2.2 Regional Seismicity

The Puget Sound Lowland is located in the forearc of the Cascadia Subduction Zone. The seismicity of the region is largely derived from the subduction of the Juan de Fuca Plate beneath the North American Plate. The seismic hazard of the region comes from three major sources: major subduction-type events, deep intraplate events (such as the 2001 Nisqually earthquake), and earthquakes due to rupture of shallow crustal faults.

The site itself is located a reasonable distance from subduction and intraslab sources, and as a result, the more local, crustal faults are believed to drive the seismic hazard for the site. The closest known active fault to the site is the Seattle Fault. The Seattle Fault is a shallow, east-west-trending thrust fault that is believed to be capable of producing a magnitude 7 event, which could impose significant seismic demands at the site.

3 SUBSURFACE EXPLORATION

Clearcreek Contractors, under subcontract to Shannon & Wilson, excavated seven test pits between August 7 and 8, 2018. A Shannon & Wilson representative was on site to observe the excavation, collect soil samples, and perform infiltration testing. The approximate test pit locations are shown in the Site and Exploration Plan, Figure 2. All test pits were located in grass areas and Clearcreek used a mini excavator with rubber treads to minimize disturbance to the site. Each test pit was backfilled with the excavated soil immediately after the excavation or infiltration testing was complete.

Test pits TP-1 through TP-6 were excavated on August 7, 2018, at the proposed locations of the expanded parking lot, bus loop, and new modular units, to evaluate soil conditions. The test pit depths ranged from 2.5 and 7 feet below ground surface (bgs).

On August 8, 2018, Clearcreek excavated test pit PIT-1 to a depth of 3 feet bgs for the PIT. PIT-1 was excavated adjacent to TP-1 near the existing bus loop (Figure 2). We performed the PIT using the small-scale method described in the Western Washington Stormwater Management Manual (WWSWMM) (Washington State Department of Ecology [Ecology], 2014). The test pit dimensions were approximately 2 by 7 feet at the bottom of the pit and 2 by 8.7 feet at the ground surface. We provide a graph of the PIT results from our manual and datalogger readings in Figure 3.

Detailed soil conditions from our exploration are presented in the test pit logs included in Appendix A. The surface elevations shown on the logs are estimated based on the record drawings for the school (Bassetti, 2001). It is expected that the test pit locations and surface elevations can be updated after the site topographic survey is available.

4 LABORATORY TESTING

Laboratory testing was conducted on several soil samples collected from the test pits to assist in classification and characterization of the subsurface soils. The laboratory tests include natural moisture content determinations, grain size analyses, and Atterberg Limits. The natural moisture contents are indicated in the test pit logs in Appendix A. The results of the grain size analyses are presented in Appendix B.

5 SUBSURFACE CONDITIONS

5.1 Site Geology and Subsurface Conditions

Our initial explorations indicate that the site is covered with a thin layer of topsoil that is underlain by reworked or native material. The reworked material consists of glacial till that was likely placed as fill during previous grading operations at the site. We also encountered glacial till and a clay deposit that appeared to be native material. The clay deposit was only encountered at one test pit location (TP-5) and overlain by approximately 1 foot of sandy silt fill.

We characterize the reworked and native glacial till as being a medium dense to very dense, clayey sand with gravel and some cobbles. We characterize the clay deposit at TP-5 as stiff, high plasticity or fat clay. Contaminated soils were not found in any of the test pits that were dug.

Grain size analyses of the till material indicated that the till soils contain approximately 32 percent of fines. Use of the on-site soils for backfilling is discussed in Section 6.6.

5.2 Hydrogeologic Conditions

Groundwater was not encountered during the explorations. However, we observed a small area of seepage in the test pit wall in TP-2, as well as iron oxide staining in soils from most of the test pits, which indicates that water was previously present. Therefore, perched water may be encountered within the fill material overlying native glacial till and clay. Perched water is more likely to be present during the wet winter/spring months.

5.3 Infiltration Potential

We measured infiltration rates between approximately 0.1 and 0.3 inch per hour during the PIT, as shown in Figure 3. In accordance with the WWSWMM, we recommend a partial correction factor of 0.50 and a design infiltration rate of 0.05 inch per hour (Ecology, 2014). The design infiltration rate is not conducive for an infiltration system onsite. Therefore, we recommend the use of an on-site detention facility to manage stormwater runoff from the proposed site improvements.

6 ENGINEERING STUDIES AND PRELIMINARY RECOMMENDATIONS

6.1 General

We understand the proposed renovations and modular units will consist of new pavement for the expanded parking lot and bus loop and new concrete pads for the modular units. Based on the observations made during the subsurface exploration program, we expect the glacial till material will provide good support for the pavement and concrete pads with minimal settlements. The clay deposit at TP-5 should provide sufficient support for a concrete pad supporting the proposed modular unit provided the bearing pressure of the structure is relatively low. In all areas, some overexcavation may be necessary to remove unsuitable fills and to provide a suitable subgrade for the pavement and concrete pads.

The following subsections provide detailed recommendations on the following topics:

- Foundation design
- Seismic design
- Lateral earth pressures

- Lateral resistance
- Earthwork and use of on-site soils

6.2 Foundation Design

We recommend an allowable bearing capacity of 2,000 pounds per square foot (psf) for concrete pads founded on native or reworked glacial till. For areas underlain by clay, we recommend an allowable bearing capacity of 1,700 psf. Concrete pads that are founded on compacted structural backfill placed above the glacial till may also be designed for an allowable bearing capacity of 2,000 psf.

The allowable bearing pressure for footing design may be increased by one-third for short-term seismic loads. Any fill material that is to be reused should be evaluated by a geotechnical engineer to see if it is suitable for use. Loose fills will require in situ densification with a heavy plate compactor (Hoe-Pac).

For concrete pads founded on till material, we estimate the settlement will be less than a ½ inch.

6.3 Seismic Design

The seismic design of the structure should be in accordance with the International Building Code (IBC) 2015 (International Code Council, 2014). The IBC design criteria are based on a target risk of structural collapse of 2 percent in 50 years. The soil profile is assessed by assigning a site class definition. It is our opinion that based on the soil classifications, the site can be classified as Site Class D.

Seismic inputs are the short-period maximum spectra acceleration, S_S, and spectral acceleration at a period of one second, S_1. Using the map provided in the IBC, which corresponds to Site Class B sites, the mapped values of S_S and S_1 are approximately 1.467 and 0.548 g, respectively. The site coefficients for the given spectral acceleration values and Site Class D are 1.0 and 1.5 for Fa and Fv, respectively. Seismic hazards, such as liquefaction and fault rupture, are not expected at this project site.

6.4 Lateral Earth Pressures

Lateral earth pressures will act on retaining walls and rockery walls as well as portions of spread footing foundations if used. The magnitude and distribution of these lateral pressures will depend on many factors, including but not limited to, the type of backfill, the method of backfill placement, level of backfill compaction, slope of backfill, drainage, and characteristics of the wall itself. If the wall is allowed to move at least 0.001 time the wall height, the wall is considered flexible and active earth pressures can be used. If the wall is considered to be inflexible, then at-rest earth pressures must be used.

The active and at-rest earth pressures, evaluated using an equivalent fluid unit weight, are estimated to be on the order of 35 and 55 pounds per cubic feet (pcf), respectively. The values given above assume a permanent wall structure, the ground surface behind the wall is level, and that proper drainage is installed to prevent the buildup of pore water pressure behind the wall. The total earth pressures should be analyzed for seismic loading conditions using a dynamic load increment equal to a percentage of the static earth force. The percentage load increase for seismic conditions was developed to be consistent with a pseudo-static analysis using the Mononobe-Okabe equation for lateral earth pressures (Kramer, 1996) and a horizontal seismic coefficient of 0.33. The load increase for seismic conditions is recommended to be a uniformly distributed load equal to 15H, where H is the height of the wall. Note the seismic coefficient is not equal to the peak ground acceleration (PGA) expected to be encountered at the site in a design event. The PGA is experienced only a few times within the record of earthquake shaking, and the actual earthquake ground motion is cyclic in nature, not static. Values of the seismic coefficient are thus typically one-third to one-half the value of the PGA that may be experienced at the site during a design-level event.

6.5 Lateral Resistance

Footings may resist lateral loads using a combination of base friction and passive pressure against the buried or embedded portion of the footings and buried wall. We recommend that base sliding resistance be determined using an allowable coefficient of friction of 0.4 for a concrete foundation founded on the on-site glacial till or compacted structural fill. For concrete foundations founded on the on-site clay, we recommend an allowable coefficient of friction of 0.2. Passive earth pressures can be evaluated using an equivalent unit weight of 290 pcf. The values above include a factor of safety of 1.5.

6.6 Earthwork and Use of On-Site Soils

Soils with high fines content (greater than 30 percent) may be or may become loose, unstable, and difficult to work with, especially during wet season grading. The on-site clay should not be used for structural fill. The native glacial till soils with up to 41 percent fines are moisture sensitive but may be suitable for use as structural fill if the moisture content can be controlled, i.e., during the dry summer months. The on-site glacial till soils may be used as structural fill material provided the following conditions are met:

- The soil is free from organics, debris, or other deleterious material.

- The water content of the on-site soil at the time of compaction is close to its optimum as determined by a Modified Proctor Test (ASTM, 2015).
- On-site soils used for fills and backfills that become wet and unstable after placement should be removed and replaced with suitable material.
- Stockpiled on-site soils are protected with plastic sheeting when rainfall is anticipated.

If on-site soil becomes too difficult to compact or construction site space limitations prevent stockpiling, we recommend using imported, granular structural backfill. Imported structural backfill should meet the gradation requirements of Section 9-03.14(1), Gravel Borrow, of the 2014 Washington State Department of Transportation (WSDOT) Standard Specifications (WSDOT, 2014). If fill is to be placed during periods of wet weather or under wet conditions, it should have the added requirement that the percentage of fines (material passing the No. 200 sieve based on wet-sieving the minus ¾-inch fraction) be limited to 5 percent. All fines should be non-plastic.

Fill placed beneath structures such as floor slabs, pavements, sidewalks, or backfill against footings should be structural fill. Structural fill should be placed and compacted upon native soil surfaces observed during construction by a geotechnical engineer or the engineer's representative. Structural fill should be placed in horizontal, uniform lifts and compacted to a dense and unyielding condition, and to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557) (ASTM, 2015). Subgrades to receive structural fill should be dense and unyielding and should be evaluated by the geotechnical engineer prior to the placement of fill. In general, the thickness of soil layers before compaction should not exceed 10 inches for heavy equipment compactors or 6 inches for hand-operated mechanical compactors. The most appropriate lift thickness should be determined in the field using the Contractor's selected equipment and fill and verified with in situ soil density testing (nuclear gauge methods). All compacted surfaces should be sloped to drain to prevent ponding. Structural fill operations should be observed and evaluated by an experienced geotechnical engineer or technician.

7 ADDITIONAL STUDIES

We recommend that the project design team review this preliminary report and advise us if additional explorations and design studies need to be performed. Additional test pits at or near the proposed structure locations may be appropriate. The number and type of explorations will depend on the type of structure, location within the site, and proximity to existing explorations, as well as other factors.

8 LIMITATIONS

This report was prepared for the exclusive use of the Tukwila School District and KMB Architects for specific application to the design of the Tukwila Elementary School Renovations and Modulars project as it relates to the geotechnical aspects discussed in this report. The data and report should be provided to prospective contractors and/or the Contractor for factual information only. Our judgments, conclusions, and interpretations presented in the report should not be construed as a warranty of subsurface conditions and should not be relied upon by prospective contractors. Construction period observation by our firm is necessary to confirm preliminary recommendations and interpretations made in this report.

9 REFERENCES

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0 2,000 4,000

Approximate Scale in Feet

NOTE

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VICINITY MAP

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FIG. 1

Filename: J:_SEA\101258\001\101258-001 Vicinity Map.dwg Date: 08-13-2018 Login: jrs

Filename: J:_SEA\101258\001\101258-001 Plan.dwg Layout: Figure 2 Date: 08-21-2018 Login: sac

0 120 240

Scale in Feet

NOTE

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LEGEND

TP-1 Test Pit Designation and Approximate Location

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SITE AND EXPLORATION PLAN

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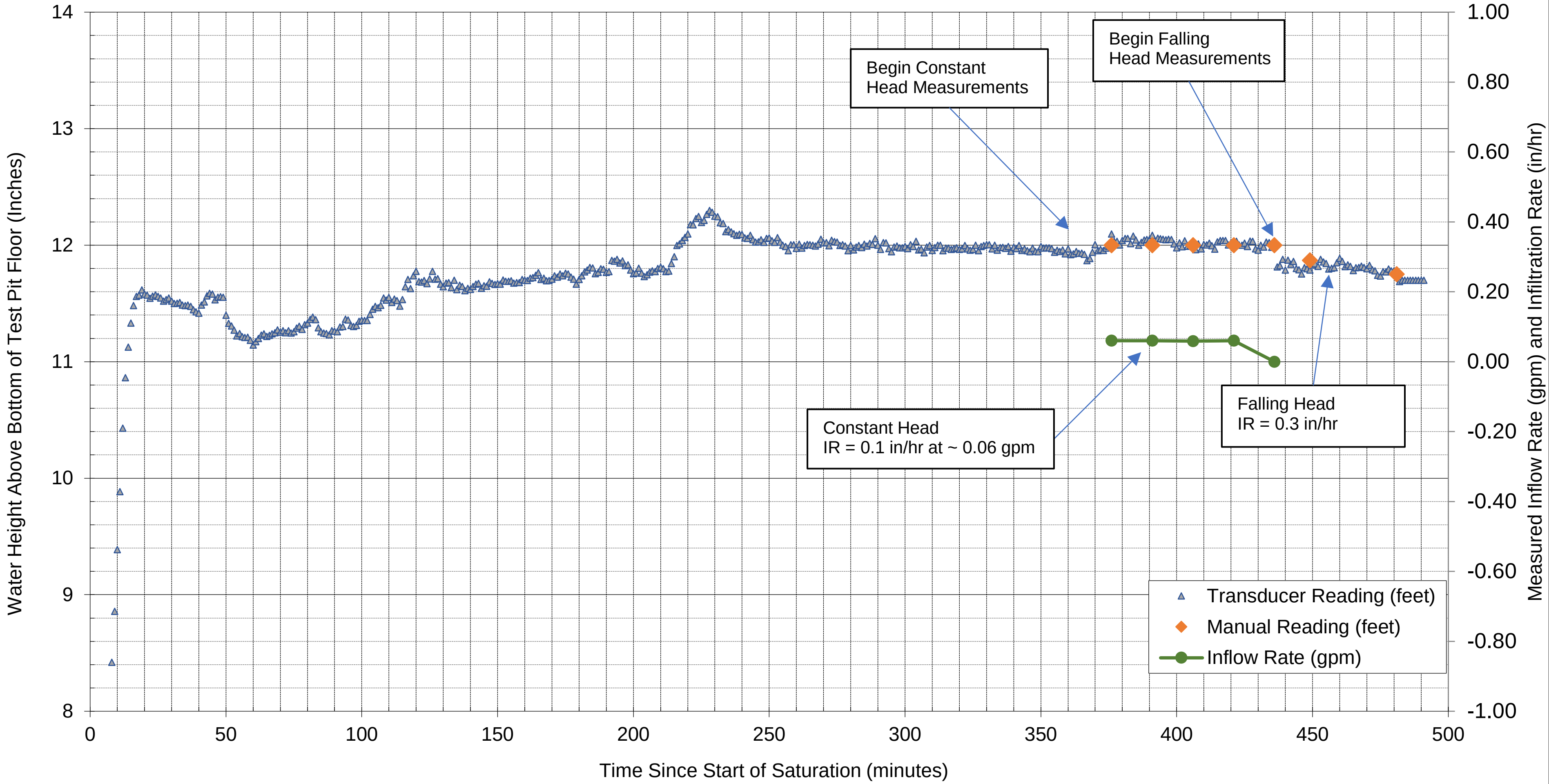
FIG. 2

FIG. 2

File: Tukwila_Test_Pit Date: 8/21/2018 Author: PVH



NOTES

1. This small-scale pilot infiltration test (PIT) was performed on August 8, 2018. Water was added to the pit from approximately 07:30 to 15:00. The surface grade elevation was approximately 187.5 feet. The water level was approximately 12 inches above the bottom of the pit during the PIT. A flow rate of 0.01 to 0.06 gpm and water level of approximately 11.8 to 11.9 inches was maintained during the last hour of saturation for the constant head test. After this period, the falling head test was conducted between 15:00 and 15:45. At the conclusion of the test, the pit did not drain and was dewatered using a sump pump. The test pit dimensions during the PIT were approximately 2 feet by 7 feet at the bottom of the pit and 2 feet by 8.7 feet at the ground surface. The bottom of the test pit is estimated to be approximately 14 square feet.

2. gpm = gallons per minute, in/hr = inches per hour, IR = measured infiltration rate

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TEST PIT PIT-1
PILOT INFILTRATION TEST DATA

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FIG. 3

FIG. 3

APPENDIX A: TEST PIT LOGS

Appendix A

Test Pit Logs

CONTENTS

Shannon & Wilson, Inc. (S&W), uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following pages. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

S&W INORGANIC SOIL CONSTITUENT DEFINITIONS

CONSTITUENT[2]	FINE-GRAINED SOILS (50% or more fines)[1]	COARSE-GRAINED SOILS (less than 50% fines)[1]
Major	***Silt, Lean Clay, Elastic Silt,*** or ***Fat Clay***[3]	***Sand*** or ***Gravel***[4]
Modifying (Secondary) Precedes major constituent	30% or more coarse-grained: ***Sandy*** or ***Gravelly***[4]	More than 12% fine-grained: ***Silty*** or ***Clayey***[3]
Minor Follows major constituent	15% to 30% coarse-grained: ***with Sand*** or ***with Gravel***[4]	5% to 12% fine-grained: ***with Silt*** or ***with Clay***[3]
	30% or more total coarse-grained *and* lesser coarse-grained constituent is 15% or more: ***with Sand*** or ***with Gravel***[5]	15% or more of a second coarse-grained constituent: ***with Sand*** or ***with Gravel***[5]

[1]All percentages are by weight of total specimen passing a 3-inch sieve.
[2]The order of terms is: *Modifying Major with Minor*.
[3]Determined based on behavior.
[4]Determined based on which constituent comprises a larger percentage.
[5]Whichever is the lesser constituent.

MOISTURE CONTENT TERMS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer:	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diam. cathead 2-1/4 rope turns, > 100 rpm NOTE: If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
Sampler:	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value:	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE NUMBER AND/OR APPROXIMATE SIZE
FINES	< #200 (0.075 mm = 0.003 in.)
SAND	
Fine	#200 to #40 (0.075 to 0.4 mm; 0.003 to 0.02 in.)
Medium	#40 to #10 (0.4 to 2 mm; 0.02 to 0.08 in.)
Coarse	#10 to #4 (2 to 4.75 mm; 0.08 to 0.187 in.)
GRAVEL	
Fine	#4 to 3/4 in. (4.75 to 19 mm; 0.187 to 0.75 in.)
Coarse	3/4 to 3 in. (19 to 76 mm)
COBBLES	3 to 12 in. (76 to 305 mm)
BOULDERS	> 12 in. (305 mm)

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
< 4	Very loose	< 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
> 50	Very dense	15 - 30	Very stiff
		> 30	Hard

WELL AND BACKFILL SYMBOLS

Bentonite Cement Grout	Surface Cement Seal
Bentonite Grout	Asphalt or Cap
Bentonite Chips	Slough
Silica Sand	Inclinometer or Non-perforated Casing
Perforated or Screened Casing	Vibrating Wire Piezometer

PERCENTAGES TERMS [1, 2]

Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

[1]Gravel, sand, and fines estimated by mass. Other constituents, such as organics, cobbles, and boulders, estimated by volume.

[2]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

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SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
Sheet 1 of 3

SOIL_CLASS_KEY_PG1 101258.GPJ SHAN_WIL.GDT 8/22/18

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL	TYPICAL IDENTIFICATIONS
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW	Well-Graded Gravel; Well-Graded Gravel with Sand
			GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM	Silty Gravel; Silty Gravel with Sand
			GC	Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW	Well-Graded Sand; Well-Graded Sand with Gravel
			SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM	Silty Sand; Silty Sand with Gravel
			SC	Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat or other highly organic soils (see ASTM D4427)

NOTE: No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.

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SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
Sheet 2 of 3

SOIL_CLASS_KEY_PG2 101258.GPJ SHAN_WIL.GDT 8/22/18

GRADATION TERMS

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

CEMENTATION TERMS[1]

Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

PLASTICITY[2]

DESCRIPTION	VISUAL-MANUAL CRITERIA	APPROX. PLASTICITY INDEX RANGE
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.	< 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 to 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 to 20
High	It takes considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	> 20

ADDITIONAL TERMS

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

PARTICLE ANGULARITY AND SHAPE TERMS[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

ACRONYMS AND ABBREVIATIONS

ATD	At Time of Drilling
Diam.	Diameter
Elev.	Elevation
ft.	Feet
FeO	Iron Oxide
gal.	Gallons
Horiz.	Horizontal
HSA	Hollow Stem Auger
I.D.	Inside Diameter
in.	Inches
lbs.	Pounds
MgO	Magnesium Oxide
mm	Millimeter
MnO	Manganese Oxide
NA	Not Applicable or Not Available
NP	Nonplastic
O.D.	Outside Diameter
OW	Observation Well
pcf	Pounds per Cubic Foot
PID	Photo-Ionization Detector
PMT	Pressuremeter Test
ppm	Parts per Million
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
q_u	Unconfined Compressive Strength
VWP	Vibrating Wire Piezometer
Vert.	Vertical
WOH	Weight of Hammer
WOR	Weight of Rods
Wt.	Weight

STRUCTURE TERMS[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

[1]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

[2]Adapted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

Tukwila Elementary School
Tukwila, Washington

SOIL DESCRIPTION AND LOG KEY

August 2018 101258-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 3 of 3

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-1

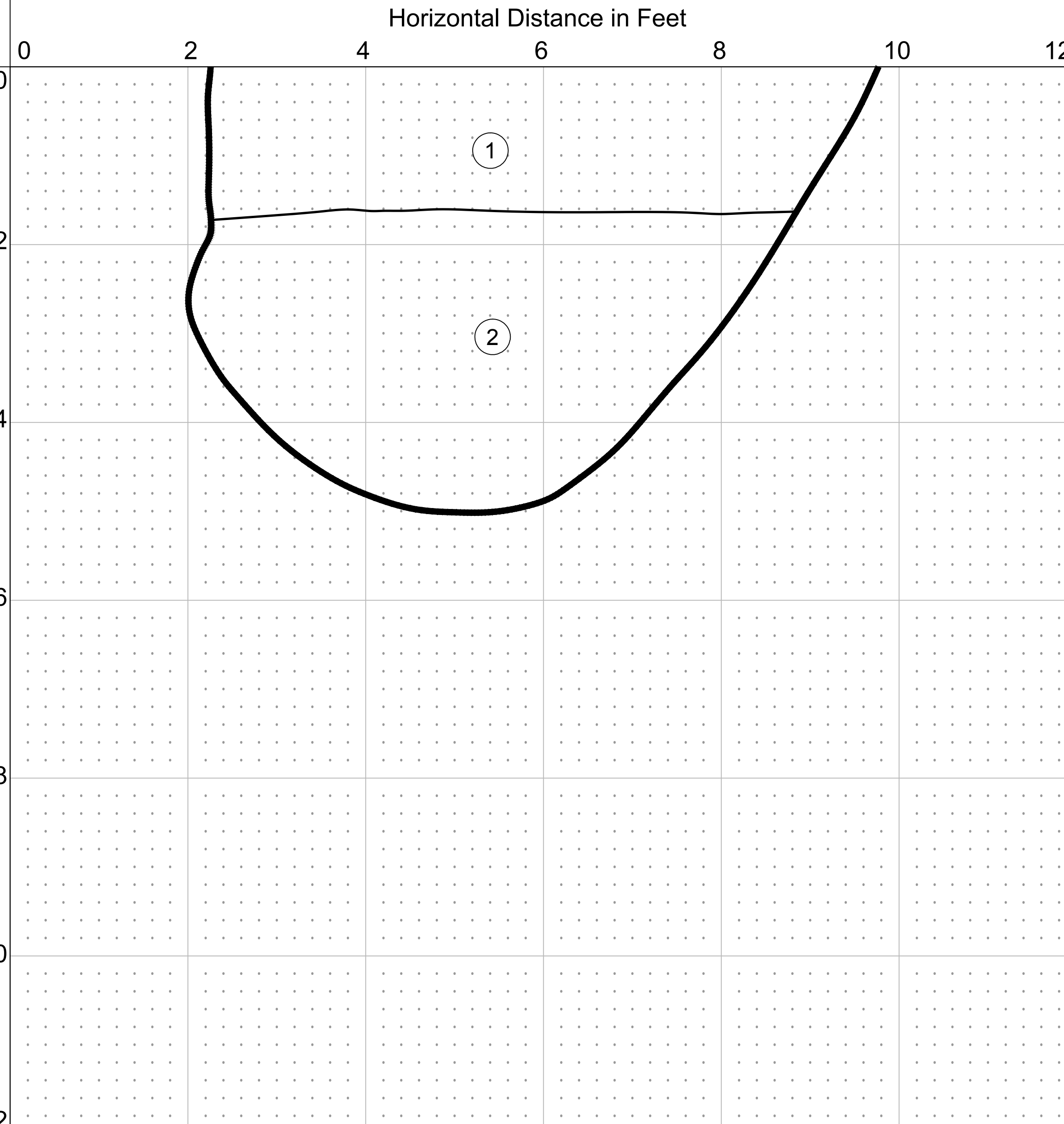
JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: Bus Loop Extension

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass	None Observed			0
(1) Soft to medium stiff, brown, *Sandy Silt (ML)*; moist.				
(2) Dense to very dense, brown, *Clayey Sand with Gravel (SC)*; moist; cobbles; low to medium plasticity fines; trace iron-oxide staining. Till (Qvt)				2
- 1.5 feet: Difficult to excavate.				
Terminated at 5 feet.			S-1	4
				6
				8
				10
				12

Sketch of North Pit Side

Surface Elevation: Approx. 187.5 Ft.



NOTE

Dimensions: 2 feet x 8 feet.

FIG. A-2

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-2

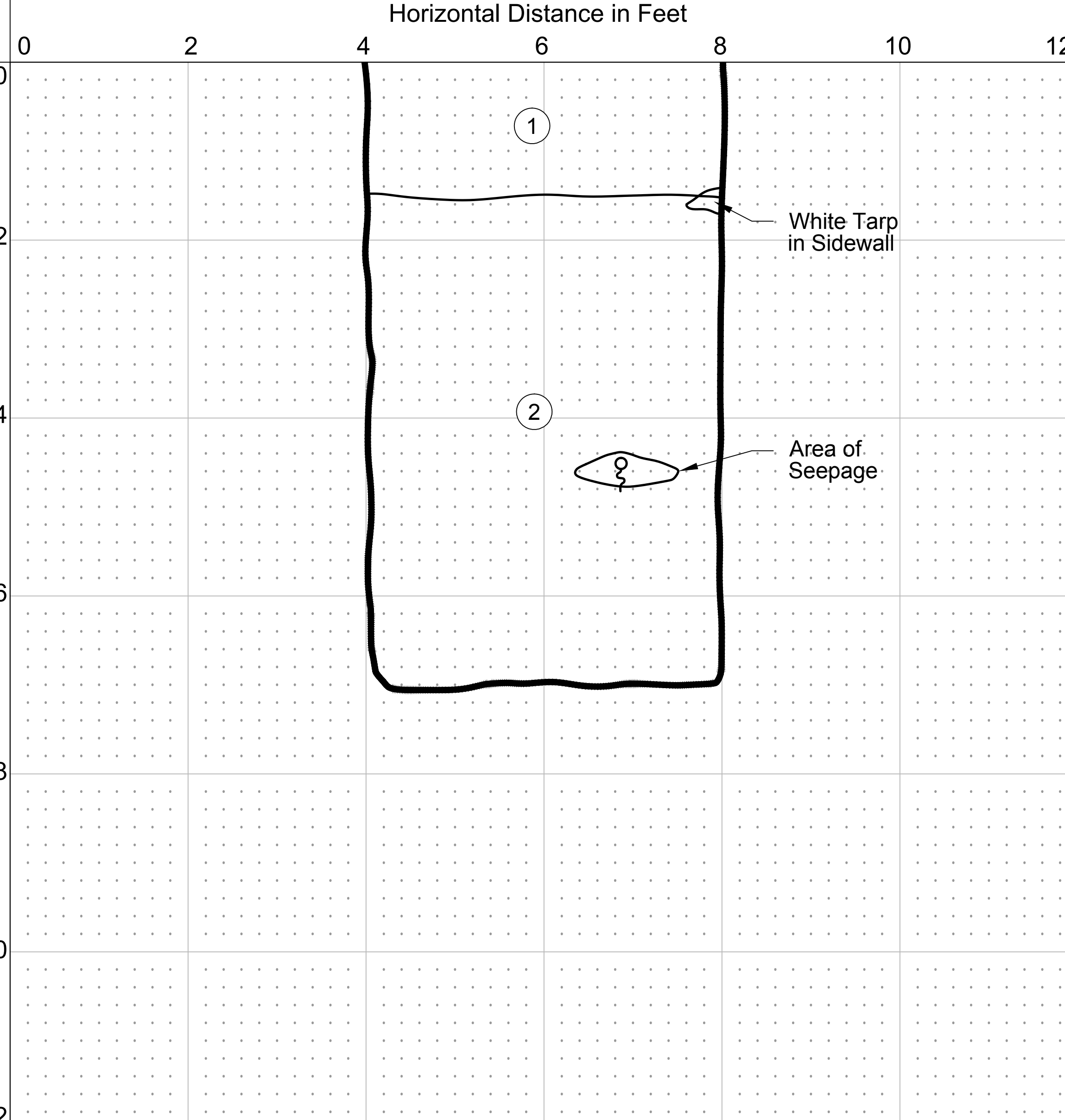
JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: Bus Loop Extension

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass				0
(1) Soft, brown, *Silty to Clayey Sand (SM/SC)*; moist; few fine to coarse gravel; trace cobbles; clay pockets. Fill (Hf) - Roots in upper 6 inches. - 2 feet: Difficult to excavate. 12" cobbles excavated.				2
(2) Medium dense to very dense, brown and gray, *Clayey Sand with Gravel (SC)*; moist to wet; cobbles; 3" diameter piece of concrete; clay pockets; trace iron-oxide staining locally.	▽		S-1	4
Terminated at 7 feet.				6
				8
				10
				12

Sketch of Southeast Pit Side

Surface Elevation: Approx. 188 Ft.



NOTE

Dimensions: 2 feet x 7 feet.

FIG. A-3

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-3

JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: Parking Lot

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass	None Observed			0
(1) Light brown, *Silty Sand with Gravel (SM)* to *Clayey Sand (SC)*; moist; trace cobbles; tree roots in upper 1.5 feet. Weathered Till and Till (Qvt)			S-1	2
- 2 feet: Difficult to excavate.				
- 2.5 feet: Boulder or bedrock, gray, 1 foot x 2 feet exposed.				
Terminated at 2.5 feet due to boulder.				4
				6
				8
				10
				12

NOTE

Dimensions: 2.5 feet x 8 feet.

Sketch of Northwest Pit Side

Surface Elevation: Approx. 194 Ft.

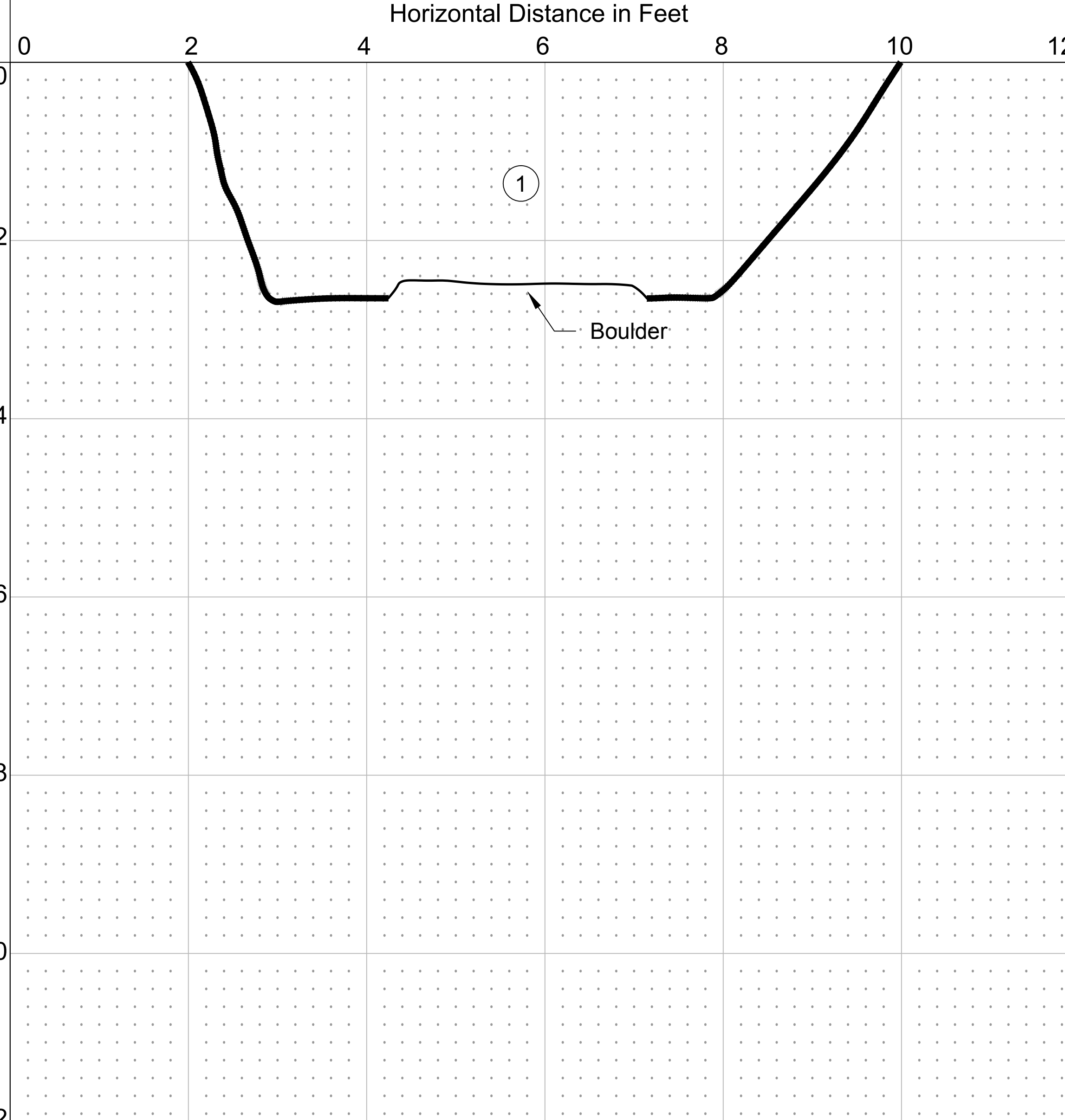


FIG. A-4

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-4

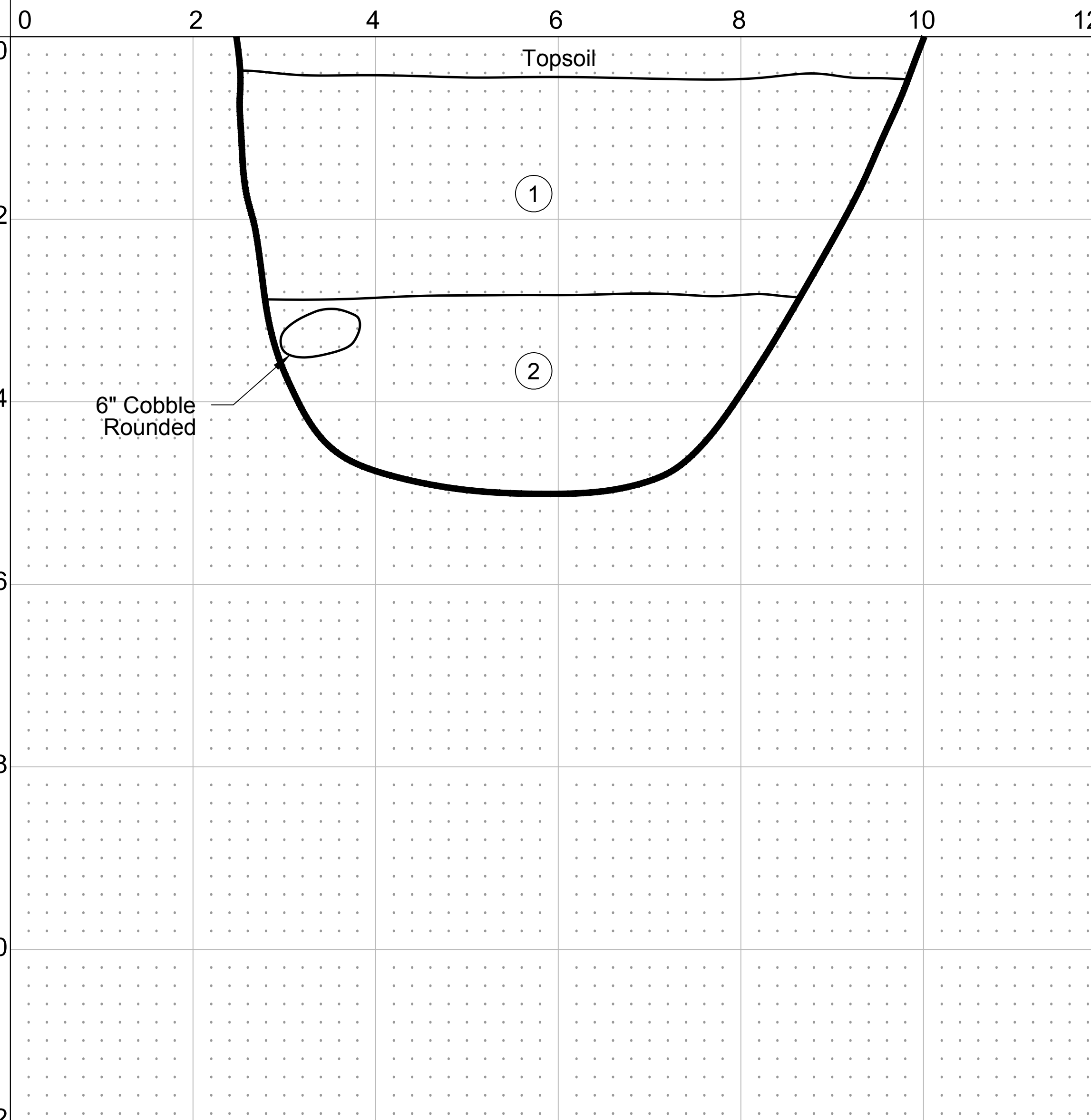
JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: Parking Lot

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
4" Grass and topsoil	None Observed			0
(1) Brown; *Silty Sand (SM)*; moist; coarse subangular to subrounded gravel; compacted; tree roots in upper 6 inches.				
(2) Dense, gray and brown, *Clayey Sand with Gravel (SC)*; moist; cobbles; low to medium plasticity fines. Till (Qvt)				2
- 3 feet: Difficult to excavate.				4
Terminated at 5 feet.		11.8	S-1	
				6
				8
				10
				12

Sketch of North Pit Side

Surface Elevation: Approx. 191 Ft.



NOTE

Dimensions: 2 feet x 7.5 feet.

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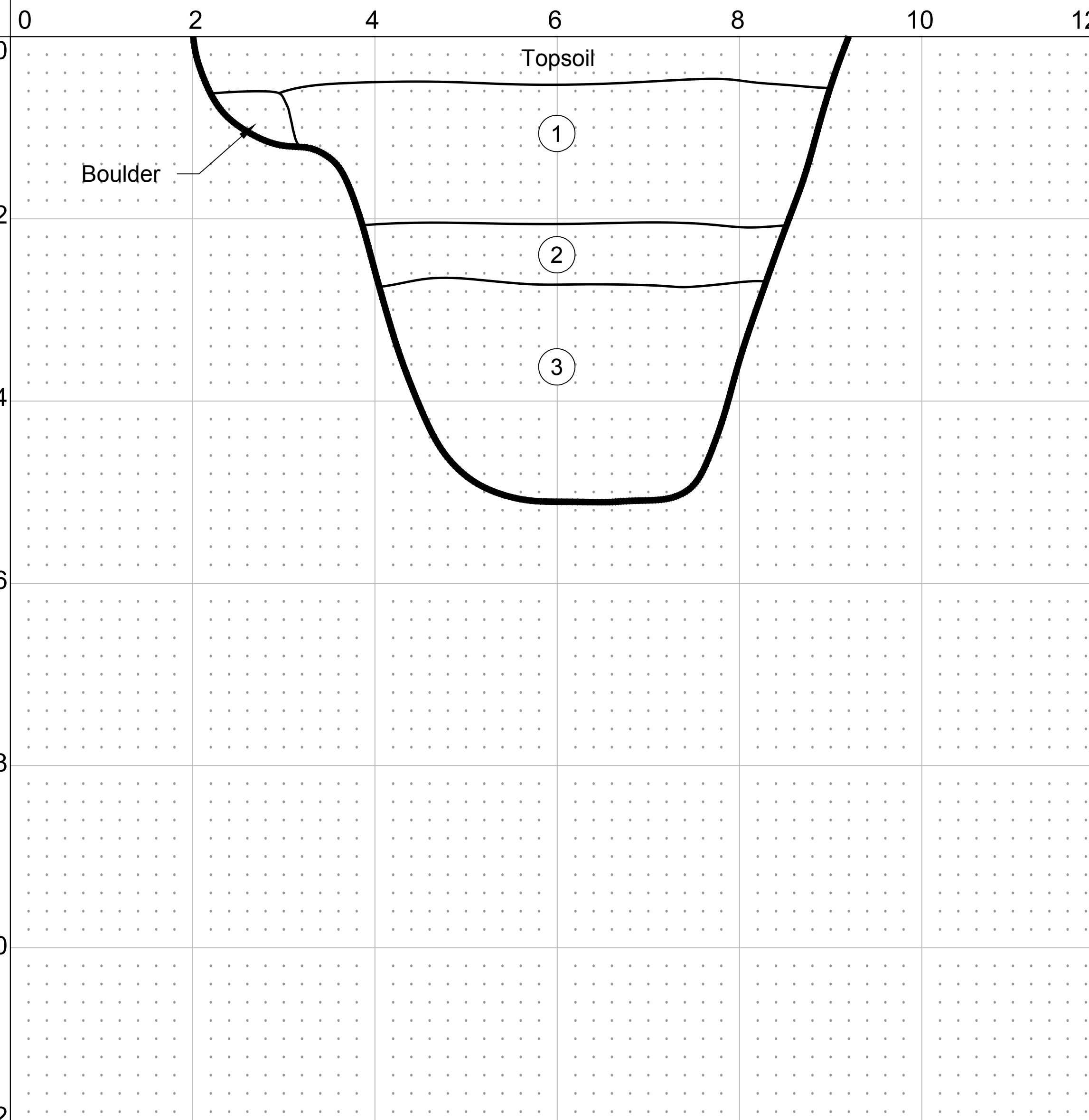
LOG OF TEST PIT TP-5

JOB NO: 101258-001   DATE: 8-7-2018   LOCATION: Adjacent to Playground

PROJECT: Tukwila Elementary School, Renovations and Modulars

Sketch of West Pit Side   Surface Elevation: Approx. 185.5 Ft.

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
4" Grass and topsoil	None Observed			0
(1) Loose, brown, *Silty to Clayey Sand with Gravel (SM/SC)*; moist; coarse gravel; roots in upper 6 inches. Fill or Reworked Earth (Hf) - 1' on south end of test pit, large boulder.				
(2) Stiff, dark brown and red, *Silt (ML) to Lean Clay (CL)*; moist; fissured; organics; iron oxide stained. Holocene Lacustrine Deposits (Hl)				2
(3) Stiff, gray, *Fat Clay (CH)*; moist; trace gravel; few fine sand pockets; high plasticity fines; organics and roots. Lacustrine Deposits (Qvrl)			S-1	4
Terminated at 5 feet.				



NOTE

Dimensions: 2 feet x 5 feet.

FIG. A-6

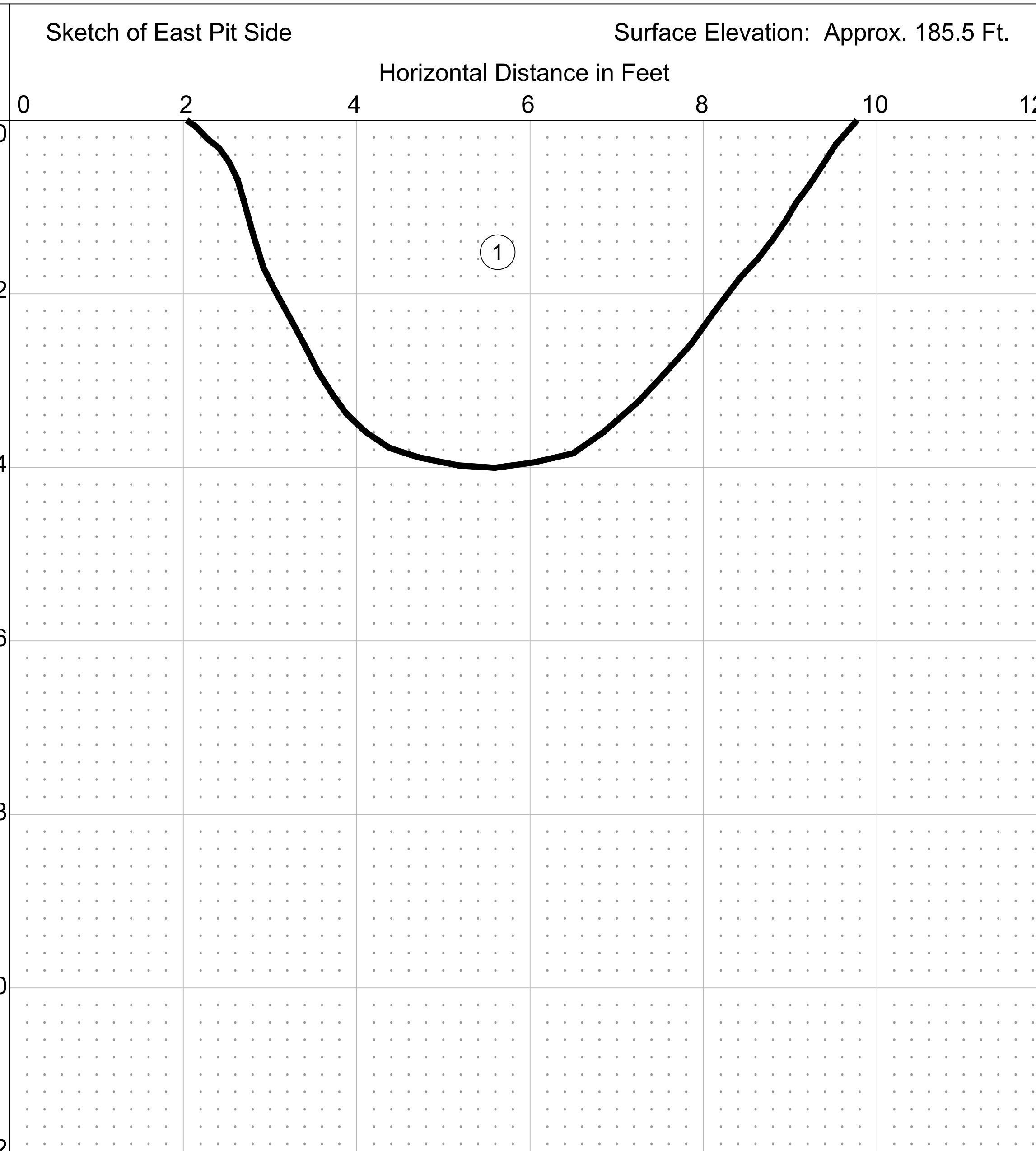
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-6

JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: East of Playground

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass (1) Medium dense to dense, brown, *Clayey Sand with Gravel (SC)*; moist; subangular to subrounded coarse gravel; few cobbles; low to medium plasticity fines; tree roots in upper 6 inches and at 2 feet. Weathered Till and Till (Qvt) - 3.5 feet: Difficult to excavate. Terminated at 4 feet.	None Observed		S-1	0, 2, 4, 6, 8, 10, 12



NOTE

Dimensions: 2 feet x 8 feet.

FIG. A-7

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT PIT-1

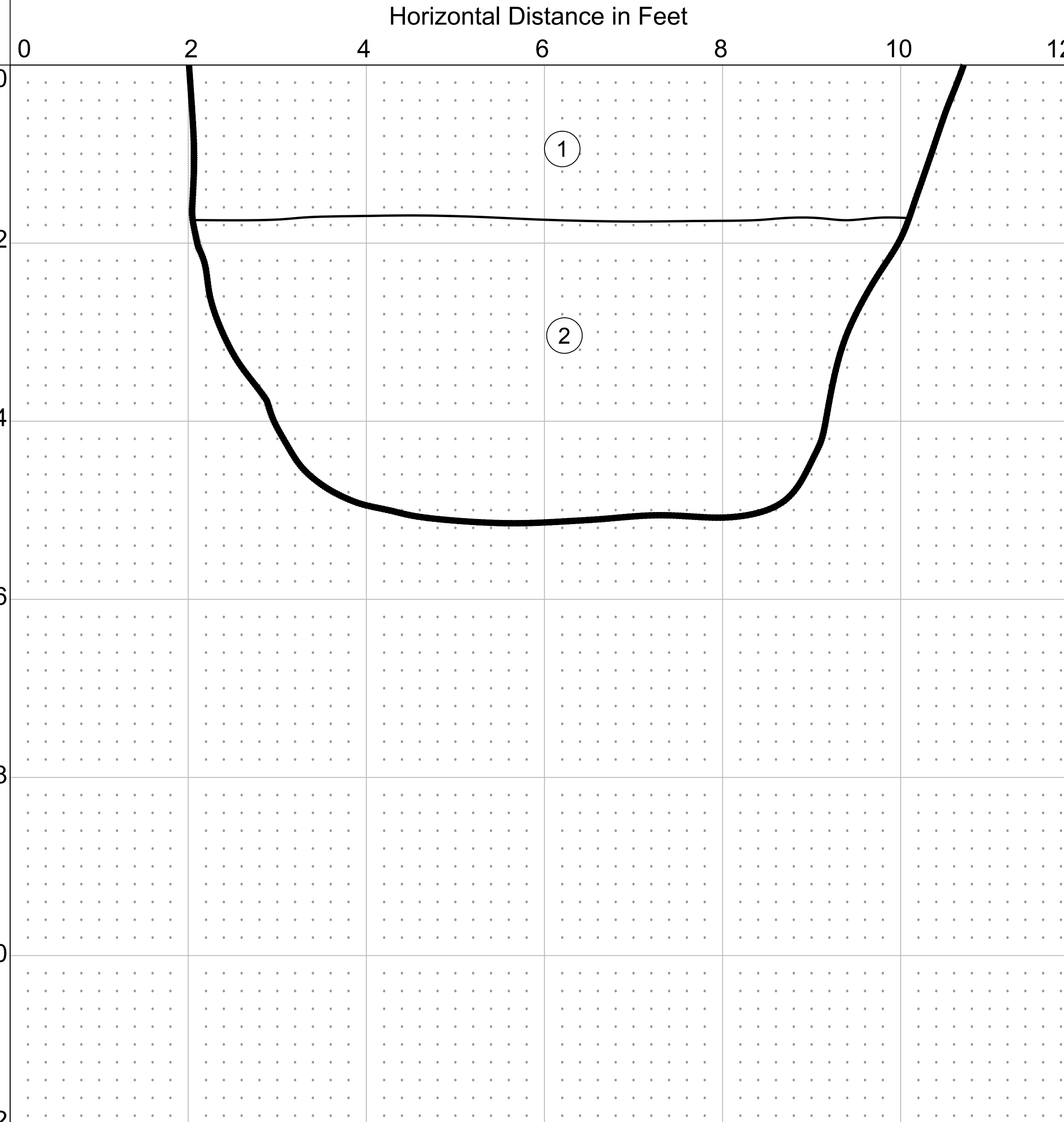
JOB NO: 101258-001 DATE: 8-8-2018 LOCATION: Bus Loop Extension

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass				0
(1) Soft to medium stiff, brown, *Silty Sand (SM)*; moist; few gravel. Fill or Reworked Earth (Hf).				
(2) Dense to very dense, brown, *Clayey Sand with Gravel (SC)*; moist; cobbles; low to medium plasticity fines. Till (Qvt)		11.3	S-1	2
Difficult to excavate.				4
Terminated at 5 feet.			S-2	
				6
				8
				10
				12

Sketch of Southwest Pit Side

Surface Elevation: Approx. 187.5 Ft.



NOTE

Dimensions: 2 feet x 8.7 feet.
Excavated test pit to 3 feet to perform Pilot Infiltration Test. Overexcavated to 5 feet after the test was completed.

FIG. A-8

APPENDIX B: LABORATORY TEST RESULTS

Appendix B

Laboratory Test Results

CONTENTS

Tables

Tests

We performed geotechnical laboratory testing on selected soil samples retrieved from the three test pits completed for the Tukwila Elementary School project. The laboratory testing program included tests to classify the soil and provide data for engineering studies. We performed visual classification on all retrieved samples. Our laboratory testing program included water content determinations, grain size distribution analyses, and Atterberg Limits determinations.

The following sections describe the laboratory test procedures.

B.1 VISUAL CLASSIFICATION

We visually classified soil samples retrieved from the borings using a system based on ASTM D2487-17, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System [USCS]), and ASTM D2488-09a, Standard Recommended Practice for Description of Soils (Visual-Manual Procedure). We summarize our classification system in Appendix A. We assigned a USCS group name and symbol based on our visual classification of particles finer than 76.2 millimeters (3 inches). We revised visual classifications using results of the index tests discussed below.

B.2 WATER CONTENT DETERMINATION

We tested the water content of selected samples in accordance with ASTM D2216-10, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. Comparison of the water content of a soil with its index properties can be useful in characterizing soil unit weight, consistency, compressibility, and strength. We present water content test results in the Laboratory Test Summary table in this appendix and on Appendix A exploration logs.

B.3 GRAIN SIZE DISTRIBUTION ANALYSIS

Grain size distribution analyses separate soil particles through mechanical or sedimentation processes. Grain size distributions are used to classify the granular component of soils and can correlate with soil properties, including frost susceptibility, permeability, shear strength, liquefaction potential, capillary action, and sensitivity to moisture. We plot grain size distribution analysis results in this appendix. Grain size distribution plots provide tabular information about each specimen, including USCS group symbol and group name, water content, constituent (i.e., cobble, gravel, sand, and fines) percentages, coefficients of uniformity and curvature, if applicable, personnel initials, ASTM standard designation, and testing remarks. Constituent percentages are presented in the Lab Summary Table in this appendix.

B.3.1 Sieve Analysis

We performed mechanical sieve analyses on selected soil specimens to determine the grain size distribution of coarse-grained soil particles in accordance with ASTM C136/C136M-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

B.4 ATTERBERG LIMITS DETERMINATION

We determined soil plasticity by performing Atterberg Limits tests on selected samples in accordance with ASTM D4318-10e1, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils, Method A (Multi-Point Liquid Limit). The Atterberg Limits include liquid limit (LL), plastic limit (PL), and plasticity index (PI=LL-PL). These limits can assist soil classification, indicate soil consistency (when compared to natural water content), provide correlation to soil properties, evaluate clogging potential, and estimate liquefaction potential.

We present soil plasticity test results in the Lab Summary Table and on plasticity charts in this appendix. Plasticity charts provide the LL, PL, PI, USCS group symbol, the sample description, water content, and percent passing the No. 200 sieve (if a grain size distribution analysis was performed).

B.5 CONSIDERATIONS

Drilling and sampling methodologies may affect the outcome of prescribed geotechnical laboratory tests. Refer to the field exploration discussion in this report for a discussion of these potential effects. Instances of limited recovery may have resulted in test samples not meeting specified minimum mass requirements per ASTM standards. Test plots show which samples do not meet ASTM-specified minimum mass requirements.

B.6 REFERENCES

ASTM International, 2017, Standard practice for classification of soils for engineering purposes (unified soil classification system), D2487-17: West Conshohocken, Pa., ASTM International, Annual book of standards, v. 04.08, soil and rock (I): D420 - D5876, 12 p., available: www.astm.org.

ASTM International, 2010, Standard test methods for laboratory determination of water (moisture) content of soil and rock by mass, D2216-10: West Conshohocken, Pa., ASTM International, Annual book of standards, v. 04.08, soil and rock (I): D420 - D5876, 7 p., available: www.astm.org.

ASTM International, 2014, Standard test method for sieve analysis of fine and coarse aggregates, C136-14/C136M-14: West Conshohocken, Pa., ASTM International, Annual book of standards, v. 04.02, concrete and aggregates, 5 p., available: www.astm.org.

ASTM International, 2010, Standard test methods for liquid limit, plastic limit, and plasticity index of soils, D4318-10e1: West Conshohocken, Pa., ASTM International, Annual book of standards, v. 04.08, soil and rock (I): D420 - D5876, 16 p., available: www.astm.org.

LABORATORY TERMS

Abbreviations, Symbols, and Terms	Descriptions
%	Percent
*	Sample specimen weight did not meet required minimum mass for the test method
"	Inch
#	Test not performed by Shannon & Wilson, Inc. laboratory
ASTM Std.	ASTM International Standard
C_c	Coefficient of curvature
Clay-size	Soil particles finer than 0.002 mm
cm	Centimeter
cm^2	Square centimeter
Coarse-grained	Soil particles coarser than 0.075 mm (cobble-, gravel- and sand-sized particles)
Cobbles	Soil particles finer than 305 mm and coarser than 76.2 mm
C_u	Coefficient of uniformity
CU	Consolidated-Undrained
ε	Axial strain
Fine-grained	Soil particles finer than 0.075 mm (silt- and clay-sized particles)
ft	Feet
γm	Wet unit weight
Gravel	Soil particles finer than 76.2 mm and coarser than 4.75 mm
G_s	Specific gravity of soil solids
H_o	Initial height
ΔH	Change in height
ΔH_{load}	End of load increment deformation
in	Inch
in^3	Cubic inch
LL	Liquid Limit
min	Minute
mm	Millimeter
μ_m	Micrometer
MC	Moisture content
MPa	Mega-Pascal
NP	Non-plastic
OC	Organic content
p	Total stress
p'	Effective stress
Pa	Pascal
pcf	Pounds per cubic foot
PI	Plasticity Index
PL	Plastic Limit
psf	Pounds per square foot
psi	Pounds per square inch
q	Deviatoric stress
Sand	Soil particles finer than 4.75 mm and coarser than 0.075 mm
sec	Second
Silt	Soil particles finer than 0.075 mm and coarser than 0.002 mm
t_n	Time to n% primary consolidation
t_{load}	Duration of load increment
tsf	Short tons per square foot
USCS	Unified Soil Classification System
UU	Unconsolidated-Undrained
WC	Water content

SAMPLE TYPES

Abbreviations, Symbols, and Terms	Descriptions
2SS	2.5-inch Outside Diameter Split-Spoon Sample
2ST	2-inch Outside Diameter Thin-Walled Tube
3HSA	3-inch CME Hollow-stem Auger Sampler
3SS	3-inch Outside Diameter Split-Spoon Sample
4SS	4-inch Inside Diameter Split-Spoon Sample
6SS	6-inch Inside Diameter Split-Spoon Sample
CA_MC	Modified California Sampler
CA_SPT	Standard Penetration Test (SPT)
CORE	Rock Core
DM	+3.25 inch Outside Diameter Split-Spoon Sample
DMR	3.25-inch Sampler with Internal Rings
GRAB	Grab Sample
GUS	3-inch Outside Diameter Gregory Undisturbed Sampler (GUS) Sample
OSTER	3-inch Outside Diameter Osterberg Sample
PITCHER	3-inch Outside Diameter Pitcher Sample
PMT	Pressuremeter Test (f=failed)
PO	Porter Penetration Test Sample
PT	2.5-inch Outside Diameter Thin-Walled Tube
ROCK	Rock Core Sample
SCORE	Soil Core (as in Sonic Core Borings)
SH1	1-inch Plastic Sheath
SH2	2-inch Plastic Sheath with Soil Recovery
SH3	2-inch Plastic Sheath with no Soil Recovery
SPT	2-inch Outside Diameter Split-Spoon Sample
SS	Split-Spoon
ST	3-inch Outside Diameter Thin-Walled Tube
STW	3-inch Outside Diameter Thin-Walled Tube
TEST	Sample Test Interval
TW	Thin Wall Sample
UNDIST	Undisturbed Sample
VANE	Vane Shear
WATER	Water Sample for Probe Logs
XCORE	Core Sample

LABORATORY TEST SUMMARY

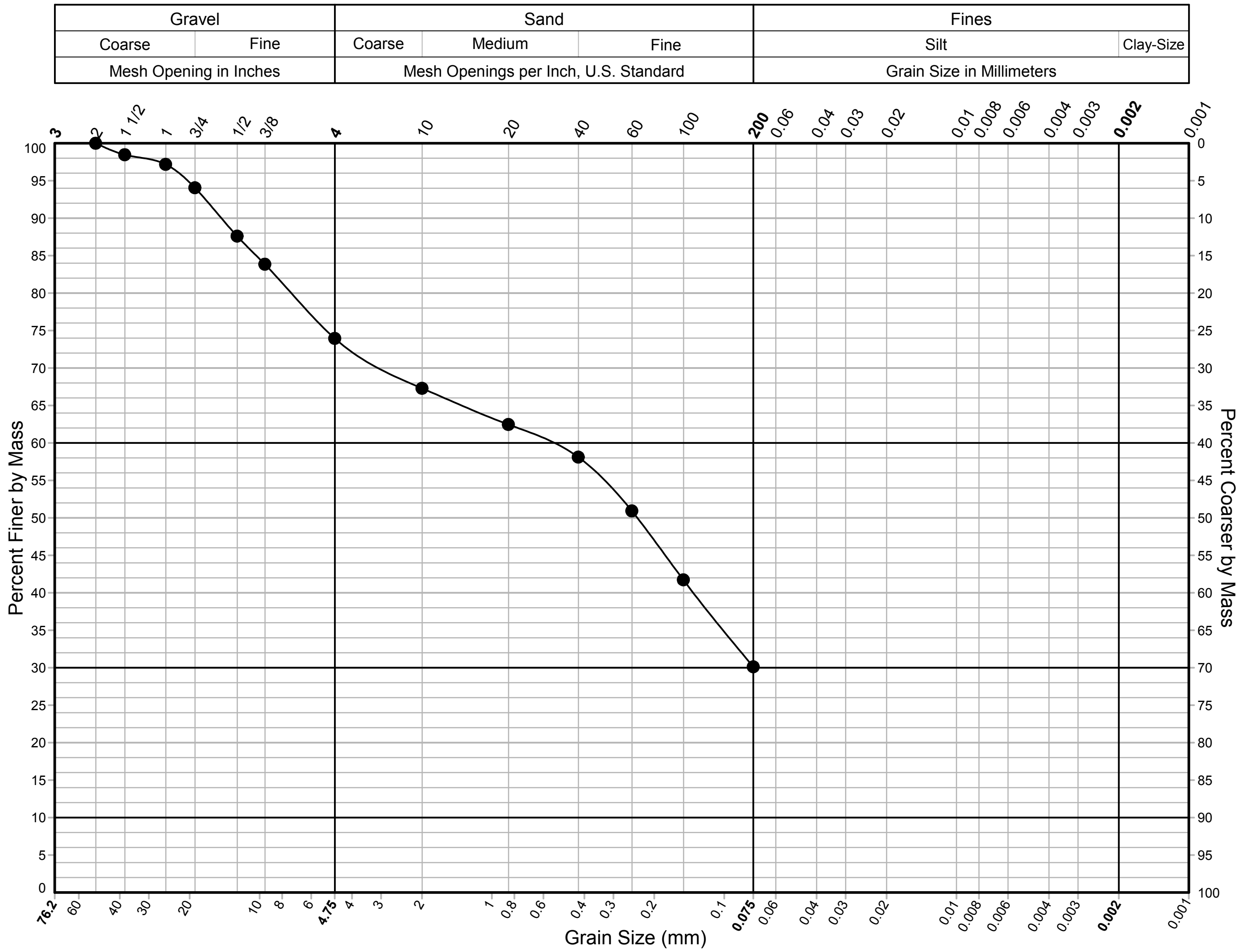
Boring	Top Depth (ft)	Sample Number	Sample Type	USCS	WC (%)	% Gravel	% Sand	% Fines	LL	PL	Soil Description
PIT-1	3	S-1	GRAB	SC	11.3	26*	44*	30*			Clayey Sand with Gravel
TP-4	4	S-1	GRAB	SC	11.8	17*	51*	32*			Clayey Sand with Gravel
TP-5	4	S-1	GRAB	CH	46.3				71	18	Fat Clay

SHANNON & WILSON, INC.

GRAIN SIZE DISTRIBUTION PLOT

Tukwila Elementary School
Tukwila, Washington

TEST PIT PIT-1



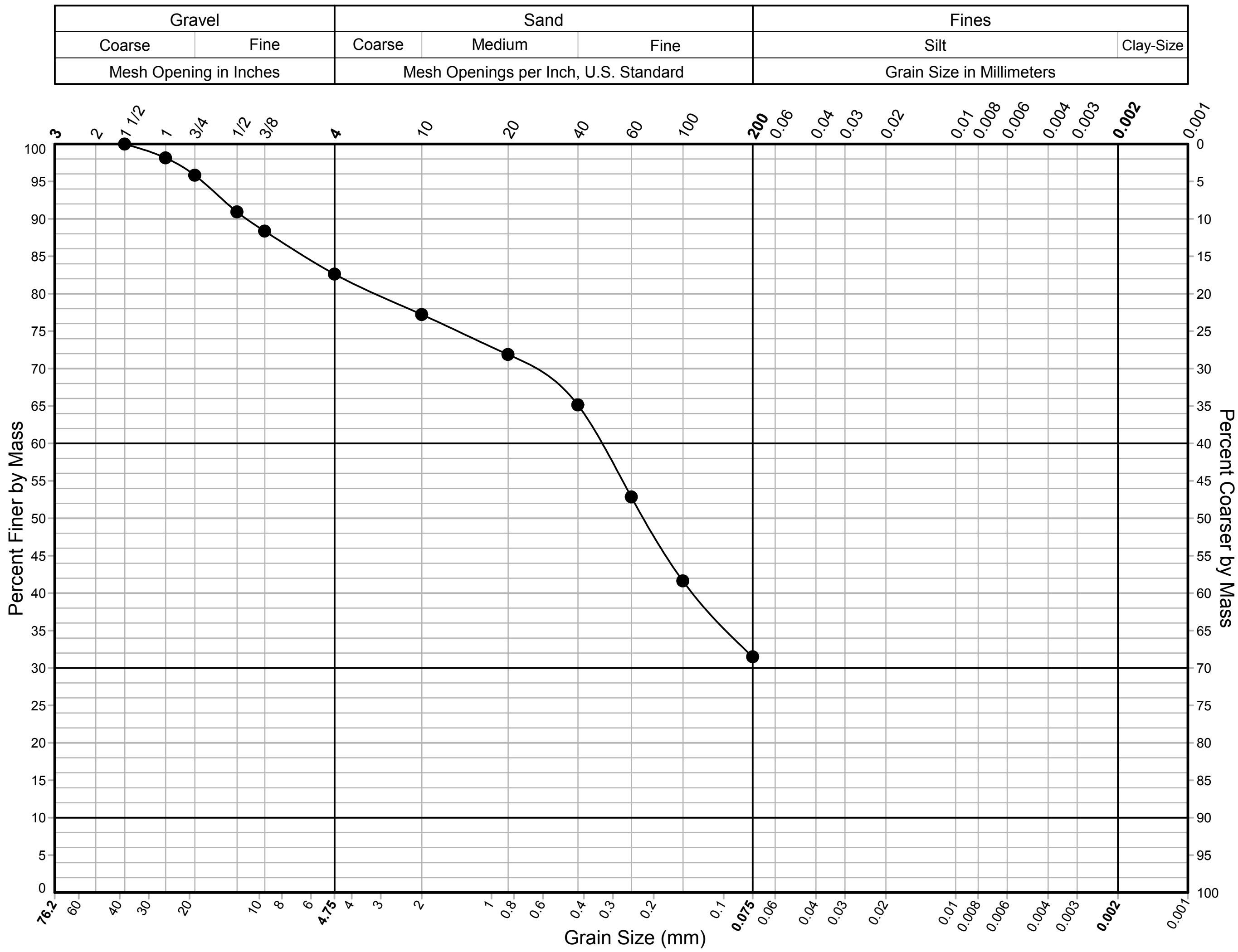
Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● PIT-1, S-1*	3.0	SC	Clayey Sand with Gravel	26	44	30			11.3	AKV	AKV	C136

* *Test specimen did not meet minimum mass recommendations.*

GRAIN SIZE DISTRIBUTION PLOT

Tukwila Elementary School
Tukwila, Washington

TEST PIT TP-4



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● TP-4, S-1*	4.0	SC	Clayey Sand with Gravel	17	51	32			11.8	AKV	AKV	C136

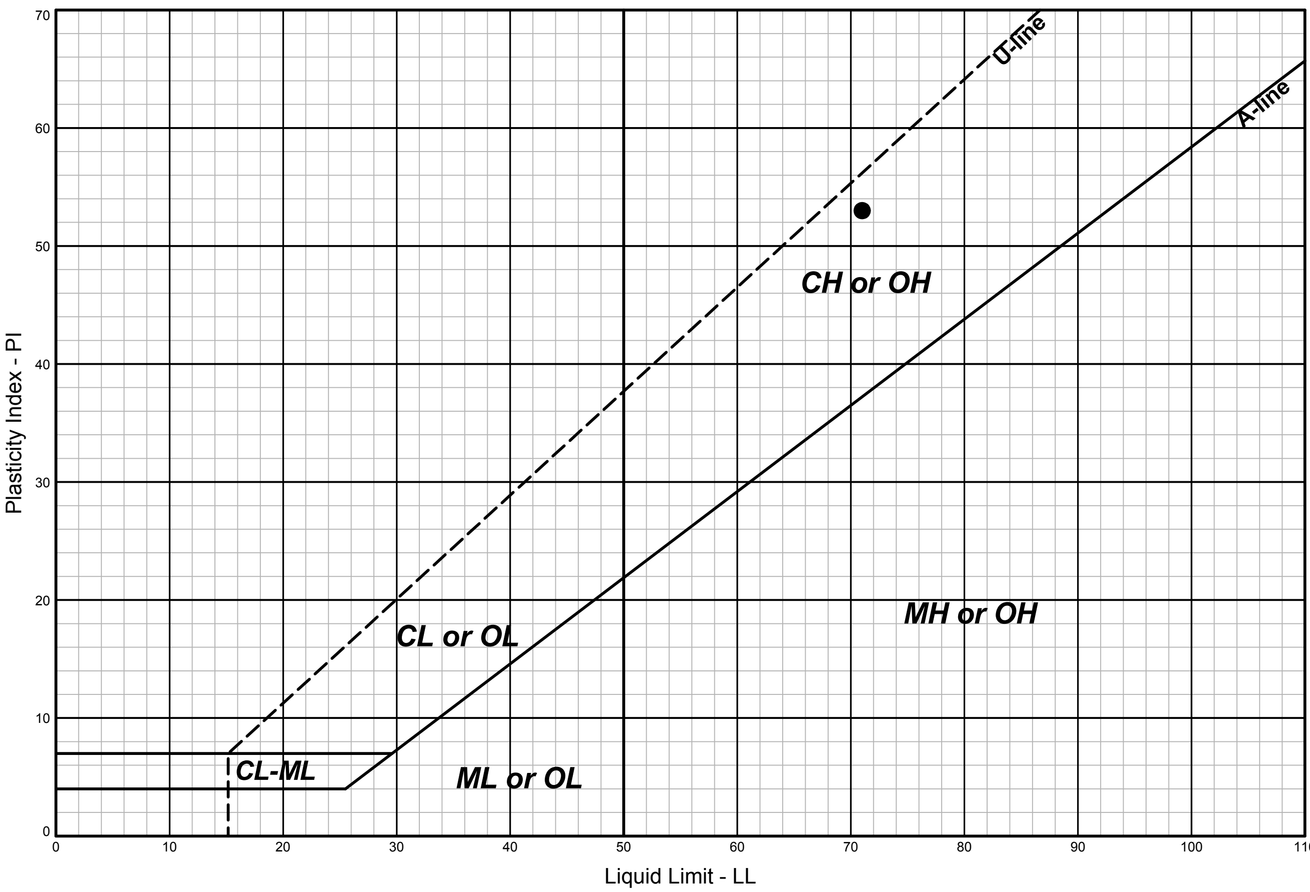
* *Test specimen did not meet minimum mass recommendations.*

SHANNON & WILSON, INC.

PLASTICITY CHART

Tukwila Elementary School
Tukwila, Washington

TEST PIT TP-5



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	LL	PL	PI	WC %	Gravel %	Sand %	Fines %	< 2µm %	Tested By	Review By	ASTM Std.
● TP-5, S-1	4.0	CH	Fat Clay	71	18	53	46.3					AKV	AKV	D4318

IMPORTANT INFORMATION

Important Information

About Your Geotechnical Report

IMPORTANT INFORMATION

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent

IMPORTANT INFORMATION

such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

IMPORTANT INFORMATION

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland