South Sound Geotechnical Consulting

January 25, 2021

PNW Group, LLC
c/o Kaul Design Architecture, PLLC
1722 Ferndale Ave. SE
Renton, WA 98058

Attention: Mr. JP Athwal

Subject: Geotechnical Engineering Report
SeaTac PNW Group Improvements
19059 International Blvd
SeaTac, Washington
SSGC Project No. 20106

Mr. Athwal,

South Sound Geotechnical Consulting (SSGC) has completed a geotechnical assessment for the above referenced project. Our services have been completed in general conformance with our proposal P20103 (dated November 18, 2020) and authorized per signature of our services agreement. Our evaluation included completion of two, engineering analyses, and preparation of this report.

PROJECT INFORMATION

Development plans include a canopy for the proposed fueling area and an addition to the north side of the exiting business building. Conventional spread footing foundations for support of the structures with concrete slab-on-grade floors for the addition.

SITE CONDITIONS

The property is located at the northwest corner of South 192nd Street and International Boulevard. An existing business structure is in the northeast portion, with most of the remainder of the site asphalt paved. A small grass area is on the north side of the existing structure where the addition is planned. A rock retaining wall borders the west side of the property, separating the site from the lower motel property to the west.

SUBSURFACE CONDITIONS

Subsurface conditions were characterized by completing two borings on December 21, 2020. Borings were advanced to final depths of 21.5 feet below existing ground surface. Approximate locations of the borings are shown on Figure 1, Exploration Plan. Logs of the borings are provided in Appendix A. A summary description of observed subgrade conditions is provided below.

Soil Conditions

Boring B-1 was located north of the existing building in the area of the planned addition. Fill consisting of a mixture of silt, sand, gravel was in a generally loose condition and extended to a depth of about 13 feet. Native soil below the fill was sand with some silt. This soil was in a medium dense to very dense condition and extended to the termination depth of the boring.

Boring B-2 was near the planned canopy area. Several layers of asphalt were below the surface with a combined thickness of about 10 inches. Similar fill (as observed in boring B-1) was below asphalt and extended to a depth of about 7 feet. Silty sand with gravel was below the fill. This soil was in a medium dense to very dense condition and extended to the bottom of the boring.

Groundwater Conditions

Groundwater was not observed in the borings at the time of drilling. However, the dense native soil observed are considered impermeable to vertical groundwater flow and can cause perched groundwater conditions, particularly during the wetter seasons of the year. Groundwater levels should be anticipated to fluctuate due to seasonal precipitation variations and on- and off-site drainage patterns.

Geologic Setting

The USGS Geologic Map of the Des Moines 7.5 Quadrangle, King County, Washington shows native soil on the site as Quaternary Vashon till. Quaternary Vashon recessional outwash is mapped to the north of the site. Native soils in the borings appear to conform to the mapped soil types.

GEOTECHNICAL DESIGN CONSIDERATIONS

The planned development is considered feasible based on subsurface conditions observed in the borings. However, the observed fill is not considered suitable for support of structures. It will be necessary to remove existing fill to competent native soils and replace with structural fill. Alternatively, pier or pile supported structures could be considered. We recommend the planned addition is placed on pile or piers due to potential affects to the retaining wall considering the amount/depth of fill that would need to be removed in this area.

Recommendations presented in the following sections are based upon the subsurface conditions observed in the borings and our current understanding of project plans. Recommendations assume finish grades will be near existing grades. It should be noted that subsurface conditions across the site may vary from those depicted on the boring logs, and can change with time. Therefore, proper site preparation will depend upon the weather and soil conditions encountered at the time of construction. We recommend SSGC review final plans and further assess subgrade conditions at the time of construction, as warranted.

General Site Preparation

Site grading and earthwork should include procedures to control surface water runoff. Grading the site without adequate drainage control measures may negatively impact site soils, resulting in increased export of impacted soil and import of fill materials, and potentially increasing the cost of the earthwork and subgrade preparation phases of the project.

Site grading should include removal (stripping) of asphalt and any fill or very loose or soft soils encountered in building areas. Stripping depths will vary across the site and can only be determined at the time of construction. Subgrades in building areas should consist of undisturbed native soil following stripping.

Total removal of existing fill in pavement areas would not be necessary if the owner is willing to accept the risk of additional future maintenance and shortened pavement lifespan. Subgrade preparation in pavement areas is further discusses in the pavement sections of this report.

General Subgrade Preparation

Subgrades in building footprints using spread footings should consist of firm, undisturbed native soil. We recommend exposed subgrades in building and conventional pavement areas are proofrolled using a large roller, loaded dump truck, or other mechanical equipment to assess subgrade conditions following stripping. Proofrolling efforts should result in the upper 1 foot of subgrade soils in building and conventional pavement areas achieving a firm and unyielding condition with a compaction level near 95 percent of the maximum dry density (MDD) per the ASTM D1557 test method. Wet, loose, or soft subgrades that cannot achieve this compaction level, as well as fill material, should be removed (over-excavated) and replaced with structural fill. The depth of over-excavation should be based on soil conditions at the time of construction. A representative of SSGC should be present to assess subgrade conditions during proofrolling.

Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Allowing surface water into cut or fill areas, utility trenches and building footprints should be prevented. Temporary and permanent drainage systems should prevent stormwater from entering excavations or flowing off-site.

Structural Fill Materials

The suitability of soil for use as structural fill will depend on the gradation and moisture content of the soil when it is placed. Soils with higher fines content (soil fraction passing the U.S. No. 200 sieve) will

become sensitive with higher moisture content. It is often difficult to achieve adequate compaction if soil moisture is outside of optimum ranges for soils that contain more than about 5 percent fines.

Site Soils: Observed fill is not considered suitable as structural fill. Native till could be suitable for use as structural fill provided it can be moisture conditioned to within optimal ranges. Some of the native soils have considerable fine (silt) content and therefore will be moisture sensitive and difficult to use as structural fill. Optimum moisture is considered within about +/- 2 percent of the moisture content required to achieve the maximum dry density (MDD) per the ASTM D-1557 test method. If moisture content is higher or lower than optimum, soils would need to be dried or wetted prior to placement as structural fill.

Import Fill Materials: We recommend import structural fill placed during dry weather consist of material which meets the specifications for *Gravel Borrow* as described in Section 9-03.14(1) of the 2018 Washington State Department of Transportation (WSDOT) Specifications for Road, Bridge, and Municipal Construction (Publication M 41-10). Gravel Borrow should be protected from disturbance if exposed to wet conditions after placement.

During wet weather, or for backfill on wet subgrades, import soil suitable for compaction in wetter conditions should be provided. Imported fill for use in wet conditions should conform to specifications for *Select Borrow* as described in Section 9-03.14(2), or *Crushed Surfacing* per Section 9-03.9(3) of the 2018 WSDOT M-41 manual, with the modification that a maximum of 5 percent by weight shall pass the U.S. No. 200 sieve for these soil types.

Structural fill placement and compaction is weather-dependent. Delays due to inclement weather are common, even when using select granular fill. We recommend site grading and earthwork be scheduled for the drier months of the year. Structural fill should not consist of frozen material.

Structural Fill Placement

We recommend structural fill is placed in lifts not exceeding about 10 inches in loose measure. It may be necessary to adjust lift thickness based on site and fill conditions during placement and compaction. Finer grained soil used as structural fill and/or lighter weight compaction equipment may require significantly thinner lifts to attain required compaction levels. Granular soil with lower fines contents could potentially be placed in thicker lifts if they can be adequately compacted. Structural fill should be compacted to attain the recommended levels presented in Table 1, Compaction Criteria.

Table 1. Compaction Criteria

Fill Application	Compaction Criteria*
Footing areas	95 %
Upper 2 feet in pavement areas, slabs and sidewalks, and utility trenches	95 %
Below 2 feet in pavement areas, slabs and sidewalks, and utility trenches	92 %
Utility trenches or general fill in non-paved or -building areas	90 %

*Per the ASTM D 1557 test method.

Trench backfill within about 2 feet of utility lines should not be over-compacted to reduce the risk of damage to the line. In some instances the top of the utility line may be within 2 feet of the surface. Backfill in these circumstances should be compacted to a firm and unyielding condition.

We recommend fill procedures include maintaining grades that promote drainage and do not allow ponding of water within the fill area. The contractor should protect compacted fill subgrades from disturbance during wet weather. In the event of rain during structural fill placement, the exposed fill surface should be allowed to dry prior to placement of additional fill. Alternatively, the wet soil can be removed. We recommend consideration is given to protecting haul routes and other high traffic areas with free-draining granular fill material (i.e. sand and gravel containing less than 5 percent fines) or quarry spalls to reduce the potential for disturbance to the subgrade during inclement weather.

Earthwork Procedures

Conventional earthmoving equipment should be suitable for earthwork at this site. Earthwork may be difficult during periods of wet weather or if elevated soil moisture is present. Excavated site soils may not be suitable as structural fill depending on the soil moisture content and weather conditions at the time of earthwork. If soils are stockpiled and wet weather is anticipated, the stockpile should be protected with securely anchored plastic sheeting. If stockpiled soils become wet and unusable, it will become necessary to import clean, granular soils to complete wet weather site work.

Wet or disturbed subgrade soils should be over-excavated to expose firm, non-yielding, non-organic soils and backfilled with compacted structural fill. We recommend the earthwork portion of this project be completed during extended periods of dry weather. If earthwork is completed during the wet season (typically October through May) it may be necessary to take extra measures to protect subgrade soils.

If earthwork takes place during freezing conditions, we recommend the exposed subgrade is allowed to thaw and re-compacted prior to placing subsequent lifts of structural fill. Alternatively, the frozen soil can be removed to unfrozen soil and replaced with structural fill.

The contractor is responsible for designing and constructing stable, temporary excavations (including utility trenches) as required to maintain stability of excavation sides and bottoms. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards. Temporary excavation cuts should be sloped at inclinations of 1.5H:1V (Horizontal:Vertical) or flatter, unless the contractor can demonstrate the safety of steeper cut slopes. Note that existing fill may require substantially shallower cuts or shoring. Permanent cut and fill slopes should be inclined at 2H:1V, or flatter. Erosion control measures should be implemented on all temporary and permanent cut or fill slopes immediately after grading.

A geotechnical engineer and accredited materials testing firm should be retained during the construction phase of the project to observe earthwork operations and to perform necessary tests and observations during subgrade preparation, placement and compaction of structural fill, and backfilling of excavations.

Foundations

Spread footing foundations can be placed on prepared native subgrade soils or on a zone of structural fill above prepared subgrades as described in this report. The following recommendations are for conventional spread footing foundations:

Bearing Capacity (net allowable):	2,500 pounds per square foot (psf) for footings supported on firm native subgrades or structural fill prepared as described in this report.
Footing Width (Minimum):	16 inches (Strip) 24 inches (Column)
Embedment Depth (Minimum):	18 inches (Exterior) 12 inches (Interior)
Settlement:	Total: < 1 inch Differential: < 1/2 inch (over 30 feet)
Allowable Lateral Passive Resistance:	325 psf/ft* (below 12 inches)
Allowable Coefficient of Friction:	0.35*

*These values include a factor of safety of approximately 1.5.

The net allowable bearing pressures presented above may be increased by one-third to resist transient, dynamic loads such as wind or seismic forces. Lateral resistance to footings should be ignored in the upper 12-inches from exterior finish grade unless restricted.

Foundation Construction Considerations

All foundation subgrades should be free of water and loose soil prior to placing concrete, and should be prepared as recommended in this report. Concrete should be placed soon after excavating and compaction to reduce disturbance to bearing soils. Should soils at foundation level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. We recommend SSGC observe all foundation subgrades prior to placement of concrete.

Foundation Drainage

Ground surface adjacent foundations should be sloped away to facilitate drainage. We recommend footing drains are installed around conventional spread perimeter footings. Footing drains should include a minimum 4-inch diameter perforated rigid plastic drain line installed along the exterior base of the footing. The perforated drain lines should be connected to a tight line pipe that discharges to an approved storm drain receptor. The drain line should be surrounded by a zone of clean, free-draining granular material having less than 5 percent passing the No. 200 sieve or meeting the requirements of section 9-03.12(2) "Gravel Backfill for Walls" in the 2018 WSDOT (M41-10) manual. The free-draining aggregate zone should be at least 12 inches wide and wrapped in filter fabric. The granular fill should extend to within 6 inches of final grade where it should be capped with compacted fill containing sufficient fines to reduce infiltration of surface water into the footing drains. Alternately, the ground surface can be paved with asphalt or concrete. Cleanouts are recommended for maintenance of the drain system.

Pier/Pile Foundations

Due to the depth of unsuitable fill on portions of this site, piles or piers may be more practical to support planned structures. Small diameter pin piles could be suitable for vertical support provided they can be properly embedded into firm glacial till.

Pin piles having diameters of 3, 4 or 6 inches would be expected. An allowable axial capacity of 6 tons for 3-inch piles, 10 tons for 4-inch pin piles, and 15 tons for 6-inch piles can be anticipated. These capacities are considered suitable for piles driven to refusal in firm glacial till. Galvanized steel should be used for the pin piles. We recommend pin piles are driven at least 5 feet into firm glacial till to the refusal criteria of the pile diameter and hammer used. We estimate pin piles will extend to depths on the order of 10 to 20 feet (from existing grades), however actual depths can only be determined at the time of driving. Acceptable refusal resistance to driving will depend on the pile diameter and hammer used. We are available to assist in assessing refusal criteria for the selected pile diameter and hammer, as needed.

Small diameter piles will not provide sufficient resistance to lateral loads. Batter piles, tiebacks, or other methods may be required to resist lateral forces on foundations supported on small diameter piles. We are available to further discuss the use of pin piles or other alternate pier/pile types.

On-Grade Floor Slabs

On-grade floor slabs should be placed on firm native soils or structural fill prepared as described in this report. Alternatively, they could be pile supported We recommend a modulus subgrade reaction of 175 pounds per square inch per inch (psi/in) for glacially consolidated native soil or compacted granular structural fill over properly prepared native soil. Floor slabs in pile supported structures should be supported on grade beams.

We recommend a capillary break is provided between the prepared subgrade and bottom of slab. Capillary break material should be a minimum of 4 inches thick and consist of compacted clean, free-draining, well graded course sand and gravel. The capillary break material should contain less than 5 percent fines, based on that soil fraction passing the U.S. No. 4 sieve. Alternatively, a clean angular gravel such as No. 7 aggregate per Section 9-03.1(4) C of the 2018 WSDOT (M41-10) manual could be used for this purpose.

We recommend positive separations and/or isolation joints are provided between slabs and foundations, and columns or utility lines to allow independent movement where needed. Backfill in interior trenches beneath slabs should be compacted in accordance with recommendations presented in this report.

A vapor retarder should be considered beneath concrete slabs that will be covered with moisture sensitive or impervious coverings (such as tile, wood, etc.), or when the slab will support equipment or stored materials sensitive to moisture. We recommend the slab designer refer to ACI 302 and/or ACI 360 for procedures and limitations regarding the use and placement of vapor retarders.

Seismic Considerations

Seismic parameters and values in Table 2 are based on the 2015 International Building Code (IBC).

Table 2. Seismic Parameters

PARAMETER	VALUE
2015 International Building Code (IBC) Site Classification[1]	D
S_s Spectral Acceleration for a Short Period	1.44
S_1 Spectral Acceleration for a 1-Second Period	0.539g
F_a Site Coefficient for a Short Period	1.00
F_v Site Coefficient for a 1-Second Period	1.5

[1] Note: In general accordance with *2015 International Building Code*, Section 1613.3.1 for risk categories I,II,III. IBC Site Class is based on estimated characteristics of the upper 100 feet of the subsurface profile. S_s, S_1, F_a, and F_v values based on the OSHPD Seismic Design Maps website.

Liquefaction

Soil liquefaction is a condition where loose, typically granular soils located below the groundwater surface lose strength during ground shaking, and is often associated with earthquakes. Native soils at relatively shallow depth consist of dense glacially consolidated materials. The risk of liquefaction is considered low for the design level earthquake at this site.

Conventional Pavement Sections

We understand removing all undocumented fill and replacement with new structural fill for access and parking areas may not be financially practical due to thickness of the fill. If the owner is willing to accept the risk of increased pavement repair and reduced pavement life, some of the fill could remain with lesser stripping (over-excavation). We recommend at least 3 feet of existing fill is removed below the base of the pavement section. Subgrades should be proofrolled to a firm condition. We recommend a separation fabric (such as Mirafi 140N, or similar) is placed on the loose subgrade prior to placement of structural fill. The purpose of the fabric is to maintain segregation between the softer subgrade soils and the coarser structural fill. Without the fabric the coarser fill will migrate into the softer fill and reduce the structural integrity of the fill zone, potentially reducing pavement life.

Subgrades for conventional pavement areas where till is present should be prepared as described in the "*Subgrade Preparation*" section of this report. Subgrades below pavement sections should be graded or crowned to promote drainage and not allow for ponding of water beneath the section. If drainage is not provided and ponding occurs, the subgrade soils could become saturated, lose strength, and result in premature distress to the pavement. In addition, the pavement surfacing should also be graded to promote drainage and reduce the potential for ponding of water on the pavement surface.

Minimum recommended pavement sections for conventional pavements are presented in Table 3. Pavement sections in public right-of-ways should conform to City of SeaTac requirements for the road designation.

Table 3. Pavement Sections

Traffic Area	Minimum Recommended Pavement Section Thickness (inches)			
	Asphalt Concrete Surface[1]	Portland Cement Concrete[2]	Aggregate Base Course[3,4]	Subbase Aggregate[5]
Parking Area	2	5	4	12
Main Access Ways	3	6	6	12

[1] 1/2 –inch nominal aggregate hot-mix asphalt (HMA) per WSDOT 9-03.8(1)

[2] A 28 day minimum compressive strength of 4,000 psi and an allowable flexural strength of at least 250 psi

[3] Crushed Surfacing Base Course per WSDOT 9-03.9(3)

[4]Although not required for structural support under concrete pavements, a minimum four-inch thick base course layer is recommended to help reduce potentials for slab curl, shrinkage cracking, and subgrade "pumping" through joints

[5] Native granular soils compacted to 95% of the ASTM D1557 test method, or Gravel Borrow per WSDOT 9-03.14(1) or Crushed Surfacing Base Course WSDOT 9-03.9(3)

Conventional Pavement Maintenance

The performance and lifespan of pavements can be significantly impacted by future maintenance. The above pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be completed. Proper maintenance will slow the rate of pavement deterioration, and will improve pavement performance and life. Preventative maintenance consists of both localized maintenance (crack and joint sealing and patching) and global maintenance (surface sealing). Added maintenance measures should be anticipated over the lifetime of the pavement section if any existing fill, topsoil, or other deleterious materials are left in-place beneath pavement sections.

REPORT CONDITIONS

This report has been prepared for the exclusive use of PNW Group, LLC for specific application to the project discussed, and has been prepared in accordance with generally accepted geotechnical engineering practices in the area. No warranties, either express or implied, are intended or made. The analysis and recommendations presented in this report are based on observed soil conditions and test results at the indicated locations, and from other geologic information discussed. This report does not reflect variations that may occur across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

This report was prepared for the planned type of development of the site as discussed herein. It is not valid for third party entities or alternate types of development on the site without the express written

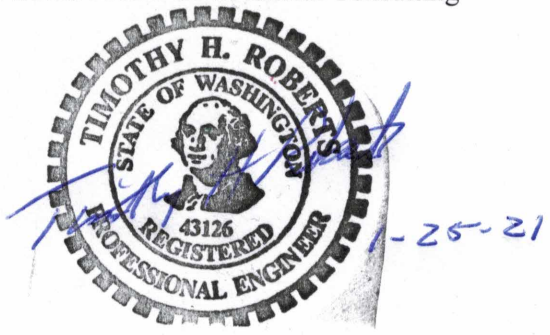
consent of SSGC. If development plans change we should be notified to review those changes and modify our recommendations as necessary.

The scope of services for this project does not include any environmental or biological assessment of the site including identification or prevention of pollutants, hazardous materials, or conditions. Other studies should be completed if the owner is concerned about the potential for contamination or pollution.

We appreciate the opportunity to work with you on this project. Please contact us if additional information is required or we can be of further assistance.

Respectfully,

South Sound Geotechnical Consulting



Timothy H. Roberts, P.E.
Member/Geotechnical Engineer

Attachments: Figure 1 – Exploration Plan
Appendix A – Field Exploration Procedures and Boring Logs
Unified Soil Classification System

N

Legend

B- 1

Approximate Boring Location

No Scale

Base map from drawing title "Site Plan' SheetA0.1, prepared by Kaul Design Architecture.

South Sound Geotechnical Consulting
P.O. Box 39500
Lakewood, WA 98496
(253) 973-0515

Figure 1 – Exploration Plan

SeaTac PNW Group Improvements
SeaTac, WA

SSGC Project #20106

Appendix A

Field Exploration Procedures and Boring Logs

Field Exploration Procedures

Our field exploration for this project included two borings completed on December 21, 2020. The approximate locations of the borings are shown on Figure 1, Exploration Plan. Boring locations were determined by pacing from site features. Ground surface elevations referenced on the logs were inferred from Google Satellite imagery. Exploration locations and elevations should be considered accurate only to the degree implied by the means and methods used.

A private drilling company subcontracted to SSGC drilled the borings. Soil samples were collected at 2.5- to 5-foot intervals and stored in moisture tight containers for further assessment and laboratory testing. The driller was responsible for backfilling the borings in conformance with Washington State Department of Ecology regulations.

The following logs indicate the observed lithology of soils and other materials observed in the borings at the time of drilling. Where a soil contact was observed to be gradational, our log indicates the average contact depth. Our logs also indicate the approximate depth to groundwater (where observed at the time of drilling), along with sample numbers and approximate sample depths. Soil descriptions on the logs are based on the Unified Soil Classification System.

PROJECT: Seatac Gas | **JOB NO.** 20106 | **BORING** B-1 | **PAGE 1 OF** 1

Location: 19059 International Blvd, Seatac, WA | **Approximate Elevation:** 355 feet

Depth (ft)	Soil Description	Sample Interval	Sample Number	Ground Water	Penetration Resistance (▲ Standard, △ Other; Blows per foot)	N-values	Testing
	Fill: Silty SAND with gravel: Loose to medium dense, moist, brown						
			S-1			11	
5							
	Probable over-stated blow count due to debris or rock		S-2			25	
			S-3			4	
10							
			S-4			5	
	Fine to medium SAND with some silt: Medium dense to very dense, moist, brown. (SM)						
15							
			S-5			17	
20							
			S-6			68	
	Boring completed at approximately 21.5 feet on 12/21/20. Groundwater not observed at time of drilling.						
25							

Penetration Resistance scale: 0 10 20 30 40 50

Explanation

- 2-inch O.D. split spoon sample
- 3-inch I.D Shelby tube sample
- No Recovery
- ATD — Groundwater level at time of drilling or date of measurement

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content

Plastic Limit — Natural — Liquid Limit

South Sound Geotechnical Consulting	BORING LOG	Boring B-1
	Date Drilled: 12/21/20	Logged By: THR

PROJECT: Seatac Gas | **JOB NO.** 20106 | **BORING** B-2 | **PAGE 1 OF** 1

Location: 19059 International Blvd, Seatac, WA | **Approximate Elevation:** 357 feet

Depth (ft)	Soil Description	Sample Interval	Sample Number	Ground Water	Penetration Resistance (▲ Standard, △ Other; Blows per foot)	N-values	Testing
	Asphalt						
	Fill: Silty SAND: Loose, moist, brown.						
			S-1		▲	3	
5			S-2		▲	8	
	Silty SAND with gravel: Medium dense to very dense, moist, brown grading gray. (SM)		S-3		▲	48	
10			S-4		▲	20	
15			S-5		▲	>50	
20			S-6		▲	>50	
	Boring completed at approximately 21.5 feet on 12/21/20. Groundwater not observed at time of drilling.						
25							

0 10 20 30 40 50

Explanation

- 2-inch O.D. split spoon sample
- 3-inch I.D Shelby tube sample
- ⊗ No Recovery
- ▼ ATD — Groundwater level at time of drilling or date of measurement

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content

Plastic Limit — Natural — Liquid Limit

South Sound Geotechnical Consulting	BORING LOG	Boring B-2
	Date Drilled: 12/21/20	Logged By: THR

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]					Soil Classification	
					Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]		GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]		GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH		GM	Silty gravel[F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]		SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]		SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH		SM	Silty sand[G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]		CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]		ML	Silt[K,L,M]
		organic	Liquid limit - oven dried	< 0.75	OL	Organic clay[K,L,M,N]
			Liquid limit - not dried			Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line		CH	Fat clay[K,L,M]
			PI plots below "A" line		MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried	< 0.75	OH	Organic clay[K,L,M,P]
			Liquid limit - not dried			Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.