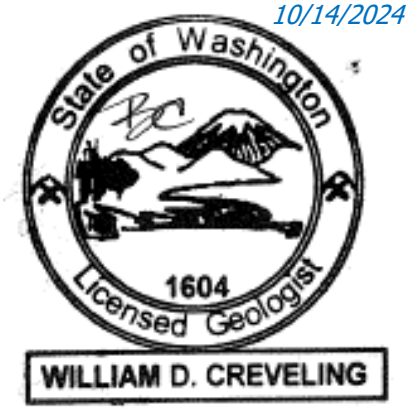
Received 12-11-2024

LEROY SURVEYORS & ENGINEERS, INC.
Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Project Name Champion Centre Geotechnical Soil Observation Report		**Job #** 12895	**Inspection Report** #1
Address / Parcel No. XXX Steilacoom Dupont RD SW / 0119362043		**Date** August 24, 2023 *Revised 10/14/2024*	**Page** 1 of 12
City / County Dupont / Pierce	**Permit #**	**Arrival Time:** 1:00 pm (5/18/2023) 12:30 pm, (8/11/2023)	
Client Mustard Seed Legacy Development, LLC (c/o David Rich)	**Project Manager** Damon DeRosa, P.E.		
Contractor James Moynan Excavating	**Project Geologist** Bill Creveling, L.G.		
Weather n/a			
Type of Work Performed Perform soil observations via soil pit excavation to determine characteristics applicable for foundation support, drainage, and constructability of the proposed development. Review 'Critical Slope' characteristics per Chapter 25.105.030.345			
Equipment Used Tracked Mini-Excavator			

10/14/2024



Project Description

A Licensed Geologist visited the above site on two occasions to oversee the excavation of 12 test pits to characterize subsurface conditions for the feasibility of a new development plan for the property. The development plan includes a proposed eating and drinking establishment on the north portion of the site development plan, and a religious assembly building on the south portion of the plan. The development will require the typical grading for building pad and parking lot design, and on-site stormwater control. Through our site observations and published sources study, the purpose of this report is to summarize the site characteristics and make appropriate recommendations for project development. This report will also address the 'Critical Slope' review comments from the City of Dupont Review Letter dated June 2, 2023.

Revision

The purpose of this revised report is to add additional information specifically related to the Gray & Osborne review comments dated February 22, 2024. Specifically, we will provide additional discussion supporting the sampling locations relative to the consistency of the surficial geology / soil deposits. To allow for ease of review, the only changes in this report to the original are in blue italics.

Gray and Osborne February 22, 2024, Review Comment

> 58. Per the DOE Manual, a minimum of two test pits are required per infiltration trench location. Figure 2 of the Geotechnical Soil Report shows 1 test pit at Infiltration Trench #1 and none at Infiltration Trench #2. Additional test pits should be provided or the Geologist provides supplemental documentation that determines the conditions are relatively uniform and the borings/test pits omitted will not influence the design or successful operation of the BMP.

Information Sources

Soil identification and mapping for this report is supported by information from the Natural Resource Conservation Service (the NRCS), and in-situ test pits excavated for our confirmation of subsurface conditions. Geologic information for this assessment is supported by information from the Washington Department of Natural Resources (DNR) Geologic Map of the Tacoma 1:100,000 Scale Quadrangle, Washington. Our understanding of site geology is supported by the review of geologic mapping, published topographic and relief map layers from the Pierce County Geographical Information System (GIS), and site observations.

We reviewed Table 1806.2 "Presumptive Load Bearing Values" of the 2018 International Building Code; we contracted Construction Testing Laboratories for Particle Size Distribution Analysis; and evaluated published geologic and terrain mapping.

Site Description

This group of properties (the Site) comprise approximately 21 acres, albeit the proposed development will occur on the south and southeast portion of the site comprising approximately 4.75 acres. The site is undeveloped. It is partially wooded and includes well-developed understory vegetation typical for the region. It is bounded on the Southeast side and the Southwest side by Steilacoom Dupont Road Southwest and Barksdale Avenue respectively. Gentle to moderate slopes descend westward into the site from Steilacoom Dupont Road and dip slightly northward from Barksdale Avenue.

Soil

According to the NRCS, the site is situated over three soil environments. However, most of the proposed development area is situated on the Spanaway gravelly sandy loam, while a small portion may extend over a transition to the Everett-Spanaway-Spana Complex. *This deposit proved to be consistent throughout the site, as would be expected by the expansive outwash plain environment on which the site is situated.* Figure 1 illustrates the site position in the soil mapping.

Figure 1: Site Position within NRCS Soil Environments (Excerpt)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
12A	Dupont muck	1.5	2.7%
41A	Spanaway gravelly sandy loam	30.8	55.0%
3112	Everett-Spanaway-Spana complex, 0 to 30 percent slopes	17.6	31.5%
Subtotals for Soil Survey Area		**49.9**	**89.1%**
Totals for Area of Interest		**56.0**	**100.0%**

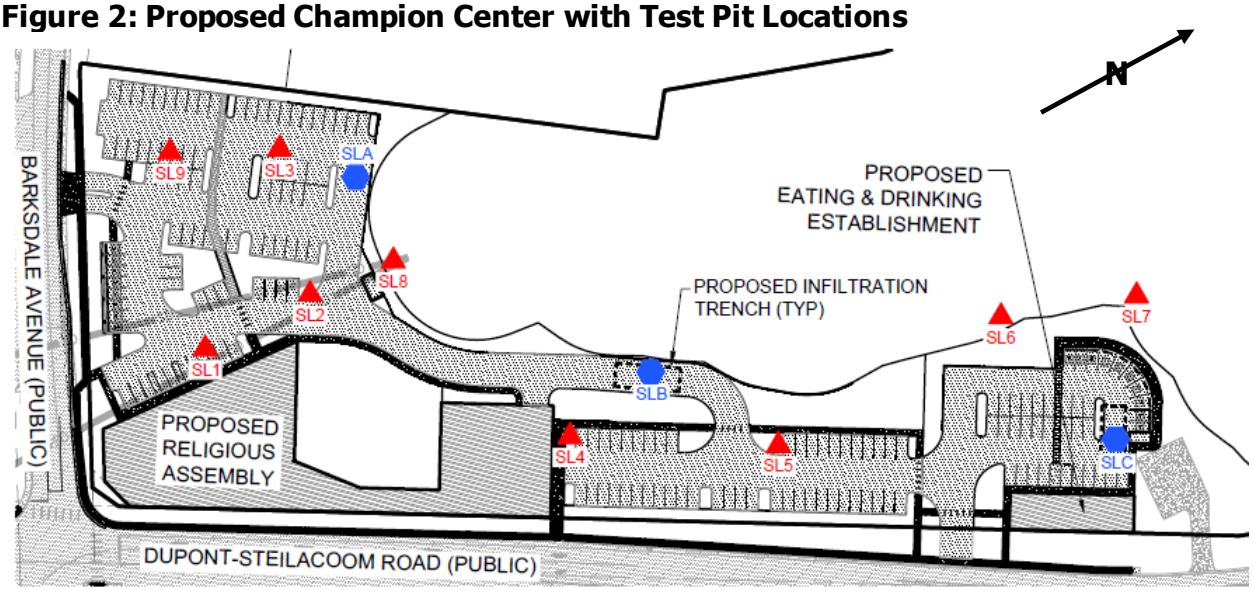
This near level to undulating Spanaway gravelly sandy loam is excessively drained. It formed in glacial outwash mixed in the upper part with volcanic ash on the very extensive plain from Lakewood to Roy. The elevation ranges from 100 to 500 feet. The annual precipitation in the region is 35 to 45 inches, and the mean annual air temperature is 51 degrees F. The frost-free season is about 170 days. Slopes range from 0 to 6 percent with the exception of anomalous Kame and Kettle features (See 'Geology' section for details).

Per the NRCS, a typical profile includes a surface layer of black gravelly sandy loam approximately 14 inches thick (but varies). The subsoil, to a depth of 18 inches, is dark grayish brown very gravelly sandy loam.

The substratum, to a depth of more at least *60 inches to several tens of feet, is light brownish gray very gravelly sand. Permeability is extremely rapid. Surface runoff is slow to non-existent, and there is little erosion hazard. Based on our test pits we can confirm the NRCS soil mapping on the site. We confirmed the site development area to be situated wholly or mostly on the Spanaway gravelly sandy loam. Figure 2 illustrates the site test pit locations on the site development plans.

*Note: the NRCS limits their analysis to the upper 60 inches of the subsurface environment even though actual depths may well exceed 60 inches (as they do in this case).

Figure 2: Proposed Champion Center with Test Pit Locations



In-Situ Soil Descriptions

▲ SOIL LOGS:
BILL CREVELING, LS&E MAY 18, 2021

SL-1
0" - 80" ALTERNATING DARK BROWN/LIGHT BROWN VERY GRAVELLY FINE-COARSE SAND (FILL)

SL-2
0" - 60" BROWN/DARK BROWN VERY GRAVELLY FINE-MED SAND W/SILT, ORGANICS (FILL)
60" - 96" BROWN VERY GRAVELLY FINE-MED SAND

SL-3
0" - 48" DARK BROWN/BLACK VERY GRAVELLY LOAM (NATIVE)
48" - 96" BROWN EXTREMELY GRAVELLY FINE-COARSE SAND W/COBBLES (NATIVE)

SL-4
0"- 18" DARK BROWN/BLACK VERY GRAVELLY LOAM (NATIVE)
18" - 96" BROWN EXTREMELY GRAVELLY FINE-COARSE SAND W/COBBLES (NATIVE)

SL-5
0" - 18" BROWN VERY GRAVELLY LOAMY SAND
18" - 80" TAN/GRAY EXTREMELY GRAVELLY FINE-COARSE SAND, ROOTS TO 80"
80"+ WATER

SL-6
0" - 10" DARK BROWN SANDY LOAM, ORGANICS
10" - 48" BROWN GRAVELLY FINE-MED SAND, ROOTED
48" - 72" GRAY GRAVELLY MED-COARSE SAND, COBBLES

SL-7
0" - 18" DARK BROWN LOAMY SAND, ROOTED, ORGANICS
18" - 70" BROWN EXTREMELY GRAVELLY FINE-COARSE SAND, COBBLES & BOULDERS

SL-8
0" - 18" BROWN VERY GRAVELLY LOAMY FINE SAND, COMPACT (FILL)
18" - 48" DARK BROWN VERY GRAVELLY LOAM (NATIVE)
48" - 80" BROWN EXTREMELY GRAVELLY FINE-COARSE SAND W/OCCASIONAL BOULDERS

SOIL LOGS:
BILL CREVELING, LS&E AUGUST 11, 2023

SL-A
0" - 36" DARK BROWN / BLACK SILT W/ FN SAND GRAVEL, ORGANIC
36" - 120" TAN GRAVEL W/ SAND

SL-B
0" - 24" DARK BROWN / BLACK SILT W/ FN SAND GRAVEL, ORGANIC
24" - 120" TAN GRAVEL W/ SAND

SL-C
0" - 54" BROWN FN-MED SAND WITH SILT, GRAVEL
54" - 120" TAN MED. SAND & GRAVEL

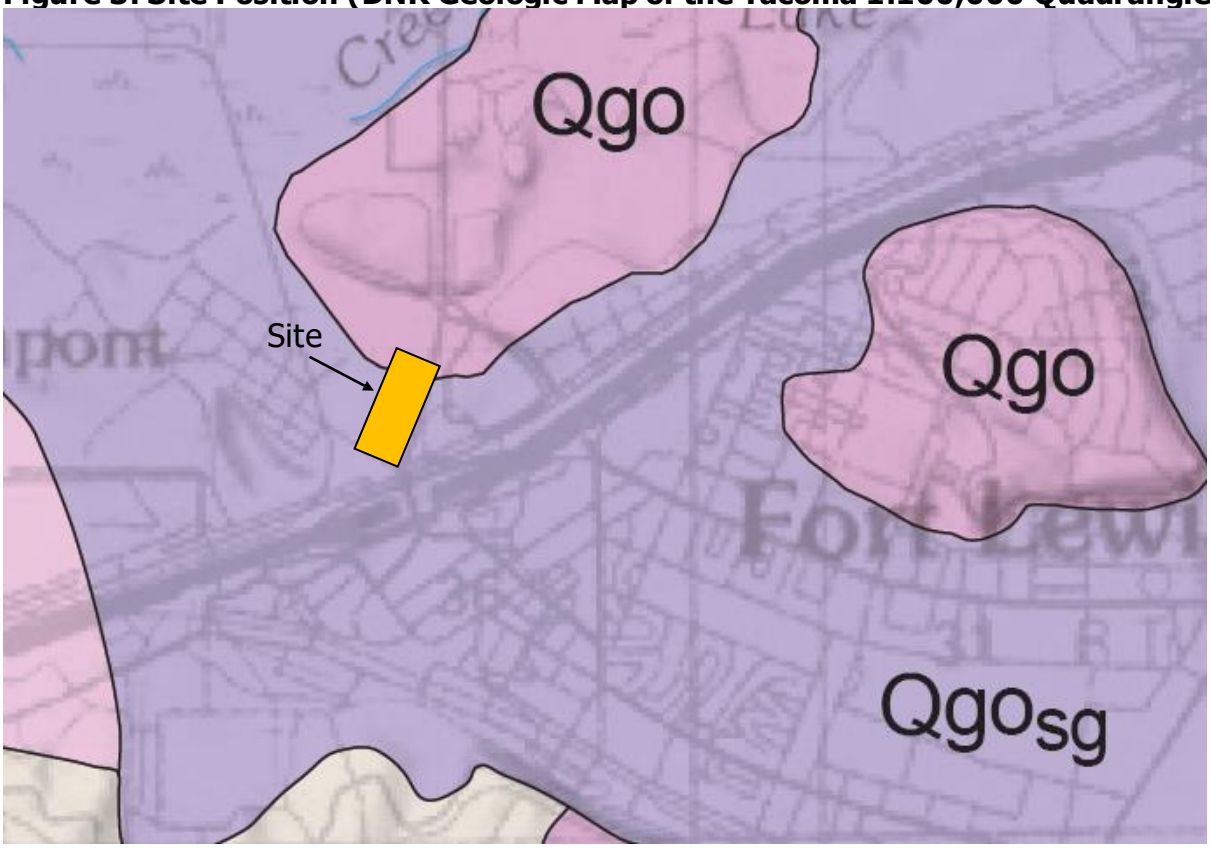
As soil logs A, B, and C illustrate, the outwash deposit is consistent in terms of depth and coarseness over a large area or entirety of the site. The deposit itself is responsible for the consistent terrain throughout the site.

Geology

According to the Geologic Map of the Tacoma 1:100,000-scale Quadrangle, Washington, in Figure 3 below; this site is located on a coarse glacial outwash deposit emplaced during a period of glacial lake outburst flooding during the end of the Fraser glaciation period. A large regional body of water trapped between glacial ice in the lowlands, and the Cascade foothills to the east was released suddenly through ice failure. This catastrophic event produced a large-scale erosion event which eroded and removed the previously emplaced glacial stratigraphy throughout the Spanaway and Lakewood area and replaced the original material in the basin with an excessively coarse outwash referred to as the Steilacoom gravel (Qgo_{sg}).

Ice blocks were transported and deposited in the terrain during this outburst flooding. Kettle formations, found throughout the broad Steilacoom Gravel deposit, were created by these large ice blocks that were left behind by the retreating glacier. Sediment was deposited around the ice blocks, leaving kettle lakes when the ice melted. This event also deposited mounds of outwash against ice blocks present on the surface, that (following melting); left 'Kame' features (isolated mounds of gravel outwash). Spanaway Lake, Gravelly Lake, and nearby Old Fort Lake are well-known examples of kettles. The mounds and knob features in the area represent these outwash gravel kames. Figure 3 illustrates the site's position in the local geology.

Figure 3: Site Position (DNR Geologic Map of the Tacoma 1:100,000 Quadrangle)



J. Eric Schuster, Ashley A. Cabibbo, Joseph Schilter, and Ian J. Hubert (October 2015)

Qgo$_{sg}$ **Recessional outwash, Steilacoom Gravel**—Pebbles with boulders; local crossbedding; kettles and other ice-contact depressions.

Throughout our experience in the Puget Sound region performing in-situ soil evaluation while comparing our findings with corresponding NRCS – Soil, and DNR or USGS - Geologic mapping, this case this case illustrates the greater accuracy of the much more current DNR geologic map (October 2015). The DNR map's depiction of the Steilacoom gravel matches the extent of our in-situ field findings better than the much older (1970's) NRCS Survey. While they both acknowledge the Spanaway soil (NRCS equivalent of glacial outburst outwash – the DNR's Steilacoom Gravel), the DNR Geologic map more accurately represents the expanse of the deposit in this area.

Our sampling points exhibited the consistency of the outwash deposit over large areas. We are confident that the expanse of this flood deposit is well established with the 11 test pits excavated throughout the site. An additional test pit in close proximity to any other test pit would exhibit the same conditions. The number and locations of sampling points are definitive in our opinion for the stormwater design.

Critical Slope Assessment

Per the City of Dupont's June 2, 2023, review letter, the following discussion and exhibit information will address Comment No. 3 on page 7, regarding the requirement to assess the slope (the small 'knob' feature) with slopes of approximately 22 percent. The applicable regulatory section is in the Dupont Municipal Code (DMC) Chapter 25.105.030.345.

The Code defines as steep slope when all three of the following criteria are met:

(a) Slopes Steeper than 15%

(b) Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and

(c) Springs or groundwater seepage

As discussed in the 'Geology' section above, the localized 'knobs' or 'mounds' are Kame features. The kames are composed of the coarse recessional flood outwash that was trapped at the time between glacial ice sheet remnants. These ice sheet blocks came to rest during the flooding on the surface where outwash became deposited against them. Upon melting, the outwash gained the appearance they have today as a mounded feature.

These deposits do not have inclined geologic contacts with permeable sediment overlying impermeable sediment, nor are any springs present per our observations (nor would they be possible in this geology). The 15% slope angle and its similar call out in other jurisdictions is only intended to warrant further analysis. In no case is such a shallow slope angle unstable. The typical angle of repose (the maximum angle an unconsolidated aggregate remains stable) for clean, well sorted, semi-rounded sand is 60 to 70 percent. The aggregate on this site has a steeper angle of repose given the poor sorting and minor sub-rounding form of the aggregate. The slope is globally stable in our opinion.

Findings/Recommendations

Foundation Bearing Capacity – The site is situated on loose gravel and sand, which is ideal for projects requiring moderate to significant bearing capacity, and limited space for drainage. However, due to the coarse nature of the aggregate, excavations may calve or settle laterally at approximately 2:1 (Vertical: Horizontal). Therefore, excavations should be laid back at 1 to 1 during construction. The 2018 International Building Code (IBC) Chapter 18 provides expected capacities for *Vertical Bearing Capacity, Lateral Bearing Pressure, and Lateral Coefficient of Friction* based on material classification. Please see Figure 3 below for an illustration of expected bearing capacity per the IBC.

Figure 3 – 2018 International Building Code (IBC) Excerpt

TABLE 1806.2
PRESUMPTIVE LOAD-BEARING VALUES

CLASS OF MATERIALS	VERTICAL FOUNDATION PRESSURE (psf)	LATERAL BEARING PRESSURE (psf/ft below natural grade)	LATERAL SLIDING RESISTANCE	
			Coefficient of friction[a]	Cohesion (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and gravel (GW and GP)	3,000	200	0.35	—
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	—
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	—	130

Foundation Drainage – As discussed in the 'Soil' and 'Geology' sections, the site is situated on an excessively permeable outwash deposit with depths of ten or more feet based on our test pit observations and the characteristics of the Steilacoom gravel. There are no perching strata or water bearing formations present. Therefore, conventional footing drain systems should be considered in the typical manner for the building facility, albeit they may never encounter ground water.

Runoff Control – The subsurface soil characteristics are ideal for subsurface infiltration. The coarse outwash depth was verified to be at least nine to ten feet in depth but may continue to greater depths when considering the terrain and landform. Soils are excessively coarse and rapidly draining, such that infiltration testing is difficult to impossible. Attempts to presoak or even hold a static ponding level are not possible in this formation based on our experience on multiple occasions. Whether attempting a falling head test using a 6-inch pipe on neighboring sites with similar soil; the infiltration was too rapid to even establish ponding in the pipe. Therefore, we opted for a more conservative design rate sizing method by collecting soil samples from the approximate basal zone of the proposed trenches and delivered to Construction Testing Laboratory for analysis (copies attached).

Results: In this case, the test confirms that these very gravelly to extremely gravelly outwash soils are ideal for infiltration. The table below summarizes the sieve results for each sample along with the necessary correction factors to determine an appropriate design infiltration rate.

Table 1 – Grain Size Analysis with Correction Factors for Infiltration Rate

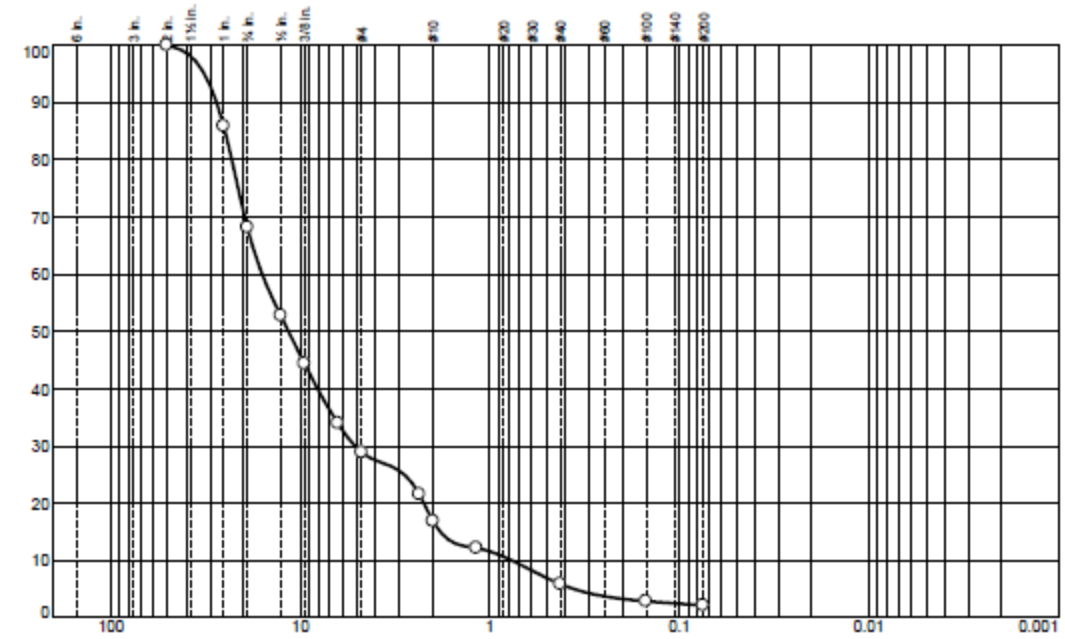
SOIL SAMPLE	D10	D60	D90	fines	1.90D10	0.015D60	0.013D90	2.08fines	log10 (Ksat)	Ksat (cm/s)	Ksat (in/hr)
SLA	0.00076	0.016	0.028	0.002	0.001444	0.00024	0.000364	0.00416	-1.57284	0.026739914	37.89909017
SLB	0.0098	0.015	0.029	0.001	0.01862	0.000225	0.000377	0.00208	-1.55361	0.027950398	39.61473765
SLC	0.0047	0.019	0.038	0.001	0.00893	0.000285	0.000494	0.00208	-1.56336	0.027330086	38.73555511

Infiltration Rate for Design - Given the substantial depth and excessive permeability of these coarse outwash soils, subsurface infiltration is ideal for stormwater control. The lowest-case recommended design rate for the three samples is 37.9 inches per hour per lab results and correction factors. We recommend using 30 inches per hour for design.

Liquefaction
The subsurface soil characteristics are such that liquefaction is not a risk. The soil is highly permeable, and free of groundwater to substantial depths. Therefore, saturated conditions are not likely to exist. Liquefaction is not expected.

See Attached Soil Test Results
Below this Page

Particle Size Distribution Report ASTM C117, C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	32	39	12	11	4	2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2"	100		
1"	86		
3/4"	68		
1/2"	53		
3/8"	44		
1/4"	34		
#4	29		
#8	22		
#10	17		
#16	12		
#40	6		
#100	3		
#200	2.2		

* (no specification provided)

Material Description

Brown Gravel with Sand
Sampled from SL A at 9'

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 27.6653 D_{85}= 24.9885 D_{60}= 15.9151
D_{50}= 11.5485 D_{30}= 5.1518 D_{15}= 1.8281
D_{10}= 0.7642 C_u= 20.82 C_c= 2.18

Classification

USCS= GW AASHTO=

Remarks

Report: #01

Sampled by: Client

Source of Sample: Existing
Sample Number: 23-1184

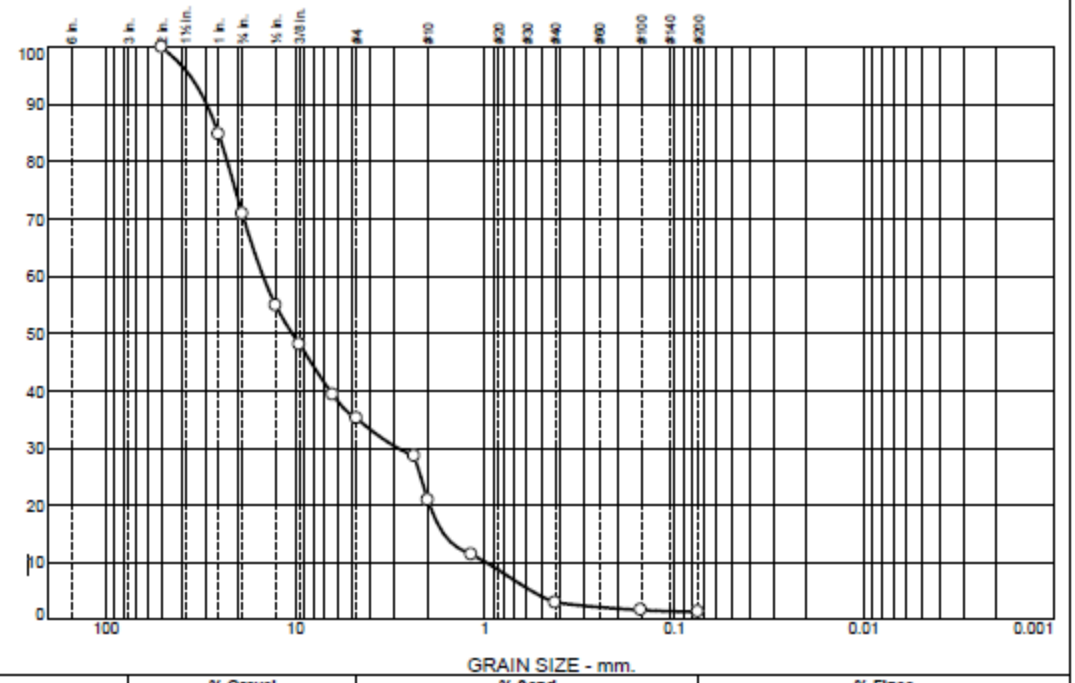
Date: 08-11-23

Construction Testing Laboratories
400 Valley Ave. NE, Suite #102
Puyallup WA, 98372 Tel. (253) 383-8778

Client: Mustard Seed Legacy Development, LLC
Project: Champion Centre
Project No: 10414 **Figure**

Tested By: R Rowden **Checked By:** C Pedersen

Particle Size Distribution Report ASTM C117, C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	29	36	14	18	2	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2"	100		
1"	85		
3/4"	71		
1/2"	55		
3/8"	48		
1/4"	39		
#4	35		
#8	29		
#10	21		
#16	11		
#40	3		
#100	2		
#200	1.4		

* (no specification provided)

Material Description

Brown Gravel and Sand
Sampled from SL B at 10'

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 29.3348 D_{85}= 25.5221 D_{60}= 14.8099
D_{50}= 10.3997 D_{30}= 2.8775 D_{15}= 1.6507
D_{10}= 0.9841 C_u= 15.05 C_c= 0.57

Classification

USCS= GP AASHTO=

Remarks

Report: #02

Sampled by: Client

Source of Sample: Existing
Sample Number: 23-1185

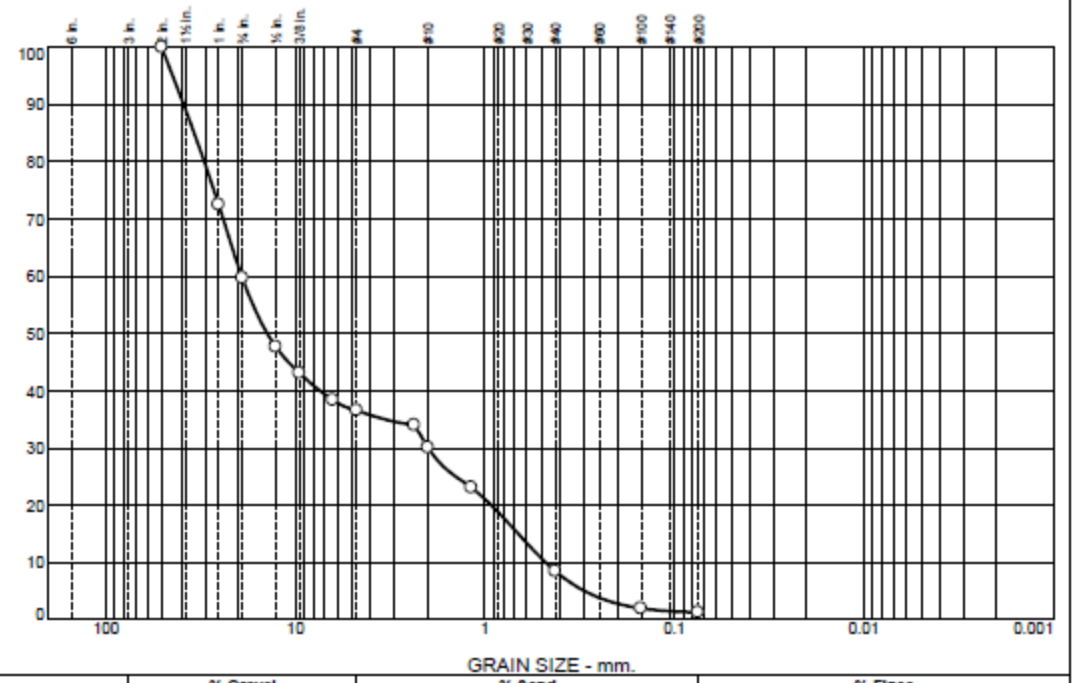
Date: 08-11-23

Construction Testing Laboratories
400 Valley Ave. NE, Suite #102
Puyallup WA, 98372 Tel. (253) 383-8778

Client: Mustard Seed Legacy Development, LLC
Project: Champion Centre
Project No: 10414 **Figure**

Tested By: R Rowden **Checked By:** C Pedersen

Particle Size Distribution Report ASTM C117, C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	40	23	7	22	7	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2"	100		
1"	72		
3/4"	60		
1/2"	48		
3/8"	43		
1/4"	38		
#4	37		
#8	34		
#10	30		
#16	23		
#40	8		
#100	2		
#200	1.3		

* (no specification provided)

Material Description

Brown Gravel with Sand
Sampled from SG C at 10'

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 38.8807 D_{85}= 34.1865 D_{60}= 19.1923
D_{50}= 14.0747 D_{30}= 1.9911 D_{15}= 0.6658
D_{10}= 0.4770 C_u= 40.23 C_c= 0.43

Classification

USCS= GP AASHTO=

Remarks

Report: #03

Sampled by: Client

Source of Sample: Existing
Sample Number: 23-1186

Date: 08-11-23

Construction Testing Laboratories
400 Valley Ave. NE, Suite #102
Puyallup WA, 98372 Tel. (253) 383-8778

Client: Mustard Seed Legacy Development, LLC
Project: Champion Centre
Project No: 10414 **Figure**

Tested By: R Rowden **Checked By:** C Pedersen