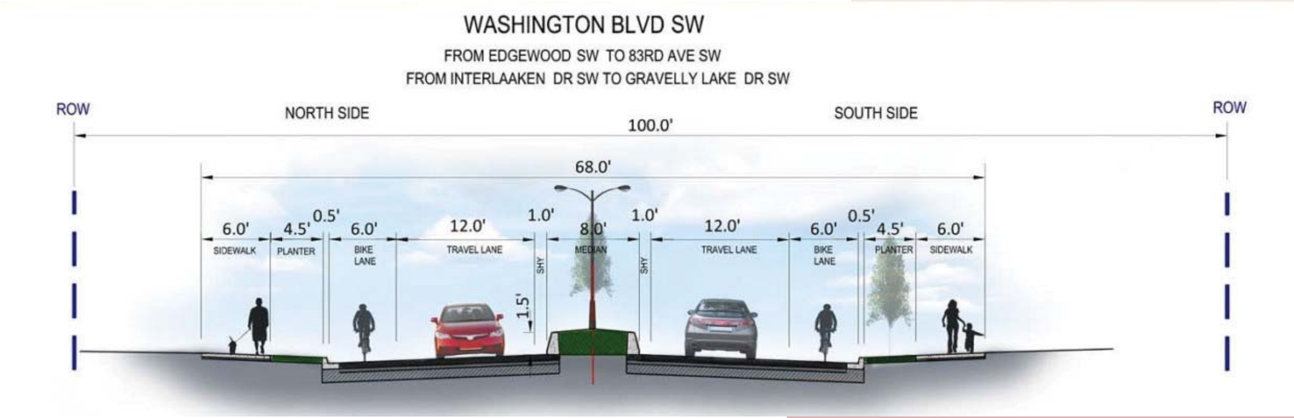
Appendix E
Geotechnical Report

GEOTECHNICAL REPORT
JBLM – NORTH ACCESS IMPROVEMENT PROJECT
Washington Boulevard Southwest and Gravelly Lake Drive Southwest Lakewood, Washington

PROJECT NO. 20-024
June 2020



Prepared for:

Parametrix, Inc.

PanGEO INCORPORATED

Geotechnical & Earthquake Engineering Consultants

PanGEO
INCORPORATED
Geotechnical & Earthquake
Engineering Consultants

June 9, 2020
Project No. 20-024

Mr. Austin Fisher, P.E.
Parametrix
1019 39th Avenue Southeast, Suite 100
Puyallup, Washington 98374

Subject: **Geotechnical Report**
JBLM -- North Access Improvement Project
Washington Boulevard Southwest and Gravelly Lake Drive Southwest
Lakewood, Washington

Dear Mr. Fisher:

Attached please find our geotechnical report for the proposed JBLM – North Access Improvement Project, Washington Boulevard Southwest and Gravelly Lake Drive Southwest, Lakewood, Washington.

In summary, based on the results of our study, it is our opinion the proposed improvements may be constructed as planned. The near surface soils along the alignment consist of medium dense to very dense silty fine to coarse sand with an abundance of gravel. The soils should provide suitable support for the planned roadway improvements and are considered conducive for infiltration.

We appreciate the opportunity to be of service. Please call if you have any questions.

Sincerely,

Siew L. Tan, P.E.
Principal Geotechnical Engineer

3213 Eastlake Avenue E, Ste B
Seattle, WA 98102
Tel (206) 262-0370
Fax (206) 262-0374

TABLE OF CONTENTS

LIST OF ATTACHMENTS

GEOTECHNICAL REPORT
JBLM – NORTH ACCESS IMPROVEMENT PROJECT
WASHINGTON BOULEVARD SOUTHWEST
AND GRAVELLY LAKE DRIVE SOUTHWEST
LAKEWOOD, WASHINGTON

1.0 INTRODUCTION

PanGEO has completed a geotechnical study for the JBLM – North Access Improvement Project in Lakewood, Washington. Our scope of services included conducting a site reconnaissance, drilling eight test borings, conducting six Small Pilot Infiltration Tests, and developing the conclusions and recommendations presented in this report.

2.0 SITE AND PROJECT DESCRIPTION

The project alignment consists of portions of North Gate Road Southwest, Edgewood Avenue Southwest, Vernon Avenue Southwest, Washington Boulevard Southwest, and Gravelly Lake Drive Southwest in Lakewood, Washington. The location of the alignment is approximately as shown on Figure 1, Vicinity Map and Figure 2, Site and Exploration Plan – Key Map. Table 1, below, provides a summary of the alignment information.

TABLE 1: Project Alignment Information

Alignment	From	To	Classification	Approximate Alignment Width (ft)	Approximate Alignment Length (ft)
North Gate Road Southwest	Edgewood Avenue Southwest	Nottingham Road Southwest	Minor Arterial	24	640
Edgewood Avenue Southwest	Washington Boulevard Southwest	Northgate Road Southwest	Minor Arterial	25	1,185
Vernon Avenue Southwest	Washington Boulevard Southwest	Veterans Drive Southwest	Minor Arterial	26	1,294
Washington Boulevard Southwest	Edgewood Avenue Southwest	Gravelly Lake Drive Southwest	Principal Arterial	45	6,072
Gravelly Lake Drive Southwest	Washington Boulevard Southwest	Nyanza Road Southwest	Principal Arterial	45	5,197
				Total	14,388

The project alignment extends through residential and commercial neighborhoods. The existing roads have an asphalt paved surface with a combination of curb and gutter and sidewalks along portions of Washington Boulevard Southwest and Gravelly Lake Drive Southwest. The roads provide two travel lanes with Washington Boulevard and Gravelly Lake Drive Southwest including a center turn lane. Overhead power and communications are also present along entire project alignment. The roadways are primarily used by passenger vehicles, delivery trucks, and service vehicles.

Based on review of topographic data (2-foot contour dataset) obtained from the Pierce County Open GeoSpatial Data Portal, the surface grade along the project alignment generally slopes from east to west with an elevation relief of approximately 30 feet over the length of the project area. The roadways are crowned along the centerline to provide drainage either to a curb and gutter or to the shoulder along the edges of the roadway.

We understand the proposed improvements will include the following:

- Reconstruct or improve the existing roadway along North Gate Road Southwest, Edgewood Avenue Southwest, Vernon Avenue Southwest, Washington Boulevard Southwest, and Gravelly Lake Drive Southwest;
- Construct up to ten new roundabouts for intersection control;
- Install new concrete curbs, gutters, and sidewalks along both sides of the roads;
- Widen the existing roadways to provide bicycle lanes along both sides of the roads;
- Install landscaped center medians and landscaped planting strips along the road margins;
- Construct associated stormwater treatment and infiltration facilities on the margins of the roads; and
- Install street lighting.

The proposed improvements will also include construction of four gravity retaining walls at the following locations:

- At the intersection of Alameda Avenue Southwest and Washington Boulevard Southwest two walls are planned in the southeast and southwest corners of the intersection. The walls will range from 65 to 100 feet long and 5 feet to 8¾ feet high.

- At the intersection of Washington Boulevard Southwest and Alameda Avenue Southwest, two walls are planned in the northeast corner of the intersection. These walls will range from 54 to 105 feet long and 2½ to 3¾ feet high.

3.0 SUBSURFACE EXPLORATIONS

3.1 Test Borings

Eight test borings (PG-1 through PG-8) were drilled along the project alignment on February 12 and 13, 2020. The approximate boring locations are shown on Figure 2 and Figures 3A through 3H. The borings were drilled to depths of up to 11½ feet below the existing road surface grade using hollow stem augers. Soil samples were obtained from the borings at 2½-foot depth intervals using a non-standard sampling method based off the ASTM D3550 *Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils* (often referred to as a "Modified California Sampler") in which the samples are obtained using a 3-inch outside diameter split-spoon sampler. The sampler was driven into the soil a distance of 18 inches using a 140-pound hammer falling a distance of 30 inches. The number of blows required for each 6-inch increment of sampler penetration was recorded and provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils.

A geologist and engineer from our firm were present throughout the field exploration program to observe the existing asphalt conditions, observe the drilling, assist in sampling, and to document the soil samples obtained from the borings. The completed borings were backfilled with bentonite chips and sealed with either an asphalt or concrete patch. Detailed information from the field exploration program is presented in Appendix A.

The soils were logged in general accordance with the system summarized on Figure A-1, Terms and Symbols for Boring and Test Pit Logs. Visual soil description includes evaluation of color, relative moisture content, soil type based upon grain size, and accessory soil types included in the sample. Summary boring logs are included as Figures A-2 through A-9.

3.2 Test Pit Excavations

Six test pits (PIT-1 through PIT-6) were excavated along the project alignment between February 11 and 13, 2020 for the purpose of infiltration testing. The test pits were initially excavated to about four feet below grade for testing. After the infiltration tests were completed the test pits were excavated to a maximum depth of about seven feet below grade.

The relative in-situ density of cohesionless soils, or the relative consistency of fine-grained soils, was estimated from the excavating action of the excavator, probing the sidewalls with a ½-inch diameter steel rod, and the stability of the test pit sidewalls. Where soil contacts were gradual or undulating, the average depth of the contact was recorded in the log. After the infiltration tests were completed, the excavations were backfilled with the excavated soils and the surface was tamped and re-graded smooth.

Geologists from our firm were present throughout the infiltration test program to observe the excavation, assist in sampling, and to document the soil samples obtained from the excavation and perform the tests. The approximate test pit locations are shown on Figure 2 and Figures 3A through 3H. The summary test pit logs are included in Appendix B.

Details of our infiltration testing and discussion of the test results are included in Section 6 of this report.

3.3 Previous Test Borings

During a previous geotechnical study completed for the Veterans Drive Southwest Redevelopment project, one test boring (B-8) was drilled along Gravelly Lake Drive Southwest within the current project alignment (Wood, 2019). The approximate location of Boring B-8 is shown on Figure 3F. A Log of test boring B-8 is included in Appendix C for reference.

3.4 Laboratory Testing

Laboratory tests were conducted on representative soil samples to verify or modify the field soil classification and to evaluate the general physical properties and engineering characteristics of the soil encountered.

3.4.1 Moisture Content and Grain Size Distribution Analysis

Moisture content tests and grain-size distribution analysis were performed on twelve soils samples collected from the test pits. The tests were conducted in general accordance with ASTM D2216 *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass* and ASTM D6913 *Standard Test Methods for Particle-Size Distribution*

(Gradation) of Soils Using Sieve Analysis. A summary of our test results is included in Appendix D of this report.

Soil samples from the test borings were not selected for moisture or grain size testing due to the high gravel content of the site soils resulting in limited sample sizes that were not representative of the actual subsurface conditions.

3.4.2 Cation Exchange Capacity and Organic Content

Six samples were submitted to Fremont Analytical for cation exchange capacity (CEC) testing. The CEC is a calculated value that estimates of the soil's ability to attract, retain, and exchange cation elements. It is reported in millequivalents per 100 grams of soil (meq/100g). The results of the CEC tests are discussed in Section 6.4 of this report and are provided in Appendix E.

3.4.3 Organics Content Testing

Three samples were also submitted to Fremont Analytical to determine the percent organics content. The testing was performed in general accordance with the ASTM D2974 *Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils*. Section 6.5 of this report discusses the organics test results.

4.0 EXISTING PAVEMENT

4.1 EXISTING PAVEMENT SURFACE CONDITIONS

The asphalt surface along the alignment is generally in good condition. During our field explorations, we observed little to no distress, fatigue, longitudinal/transverse cracking, or differential settlement. Asphalt patches were present in localized areas.

4.2 EXISTING PAVEMENT THICKNESS AND SUBGRADE

All eight of our test borings were drilled through the existing pavement. Concrete pavement was only encountered in Boring PG-6; the other borings did not encounter concrete pavement.

In our borings, penetration tests were performed on the pavement subgrade, immediately below the pavement layer. The objective of the tests was to evaluate the density and adequacy of the existing subgrade. In summary, based on the test results, the pavement subgrade generally consisted of a medium dense to very dense silty fine to coarse sand with gravel, which we interpret as fill. In boring PG-6 where concrete pavement was encountered, the pavement subgrade appeared not as dense as other locations, and may require re-compaction for construction of new pavement in this area.

Table 2, below, summarizes the pavement thickness and subgrade condition observed. Photos of the pavement cores from borings PG-1 through PG-8 are included in Appendix F of this report.

TABLE 2: Summary of Pavement Thicknesses

Boring	Nearest Address	Lane	Pavement Thickness
PG-1	9616 Northgate Road Southwest	West	• 4 inches of asphalt
PG-2	9025 Washington Boulevard Southwest	Center	• 6 inches of asphalt
PG-3	8807 Washington Boulevard Southwest	Center	• 3 inches of asphalt • 1½ inches of asphalt • Geotextile • 1½ inches of asphalt ***6 inches total***
PG-4	8210 Washington Boulevard Southwest	Center	• 2½ inches of asphalt • Geotextile • 3 inches of asphalt ***5½ inches total***
PG-5	7920 Washington Boulevard Southwest	Center	• 2½ inches of asphalt • Geotextile • 1½ inches of asphalt ***4 inches total***
PG-6	12108 Gravelly Lake Drive Southwest	Center	• 6½ inches of asphalt • ½ inch of gravel • 2 inches of asphalt • 8 inches of concrete ***15 inches total***
PG-7	12613 Gravelly Lake Drive Southwest	Center	• 5 inches of asphalt
PG-8	12789 Gravelly Lake Drive Southwest	Center	• 5½ inches of asphalt
B-8[1]	2318 Gravelly Lake Drive Southwest	North	• 6½ inches of asphalt

[1]-Wood (2019)

5.0 SUBSURFACE CONDITIONS

5.1 SITE GEOLOGY

According to the *Geologic Map of the Tacoma 1:100,000-Scale Quadrangle, Washington* (Schuster et. al., 2015), the project alignment is generally underlain by Quaternary recessional outwash consisting of a geologic unit named Steilacoom Gravel (Geologic Map Unit: Qgo_{sg}). Steilacoom Gravel consists of pebbles, boulders, and occasional lenses of sand that has been transported and deposited by glacial meltwater.

The project alignment has been graded to provide uniform road grades and install underground utilities. As such, we would expect the alignment to be underlain by localized area of fill, which is soil placed under the influence of humans.

5.2 SOIL CONDITIONS

For a detailed description of the subsurface conditions encountered at each exploration location, please refer to our boring and test pit logs provided in Appendices A and B. The stratigraphic contacts indicated on the logs represent the approximate depth to boundaries between soil units. Actual transitions between soil units may be more gradual or occur at different elevations. The descriptions of groundwater conditions and depths are likewise approximate. The following is a generalized description of the soils encountered in the borings.

Fill – A surficial layer of fill was encountered in all of our borings and pits. The fill ranged from six inches thick at Test Pit PIT-2 to 7½ feet thick at Boring PG-6. The fill consisted of a medium dense to very dense, silty sand containing trace to some amounts of gravel.

Based on the extent of the fill encountered at our exploration locations, it is likely the pavement subgrade soils will consist of fill.

Steilacoom Gravel (Qpo_{sg}) – Directly below the fill, all test borings and test pits encountered medium dense to very dense sandy gravel to gravelly sand containing trace amounts of silt. We interpret this unit as Steilacoom Gravel which is the primary geologic unit mapped in this area. Steilacoom Gravel was observed to the maximum exploration depth of approximately 11½ feet below grade.

Steilacoom Gravel will likely be the primary receptor soil for the infiltration system.

The fill and native soils contained gravel and cobbles which may have overstated the blowcounts from our standard penetration tests recorded on the boring logs. Based on the conditions encountered in our test pits, the soils were at least medium dense.

Our subsurface descriptions are based on the conditions encountered at the time of our exploration. Soil conditions between our exploration locations may vary from those encountered. The nature and extent of variations between our exploratory locations may not become evident until construction. If variations do appear, PanGEO should be requested to reevaluate the recommendations in this report and to modify or verify them in writing prior to proceeding with earthwork and construction.

5.3 Groundwater

During the three-week period before our field exploration, the Lakewood area received more than 8 inches of precipitation, yet no indications of seepage or groundwater were encountered at our exploration locations to the maximum exploration depth of 11½ feet. This is indicative of the relatively permeable nature of the recessional outwash underlying this area.

It should be noted that groundwater elevations may fluctuate depending on the seasonal rainfall, local subsurface and groundwater conditions, and other factors. In general, the water level is the highest and the seepage rate in the greatest during the winter and early spring (typically October through May).

6.0 INFILTRATION TESTING AND RECOMMENDATIONS

Six field infiltration tests (PIT-1 through PIT-6) were performed at the project site between February 11 and 13, 2020. The test locations are indicated on the attached Figure 2. The test method and the results are discussed below.

6.1 Test Method

The field infiltration tests were conducted in general accordance with the procedure for Small Pilot Infiltration Test (PIT) as outlined in the *Stormwater Management Manual for Western Washington published by Washington State Department of Ecology* (WDOE Manual, 2014). In general, the test consisted of the following procedure:

- A test pit was excavated to the approximate design bottom of the proposed infiltration facilities with a minimum bottom area of 12 square feet.
- The test pit was pre-soaked by maintaining a water level of at least 12 inches above the bottom of the pit.
- After the pre-soak period, a hydrant meter provided by the Lakewood Water District was used to monitor the amount of water needed to maintain a constant head of 12 inches for at least one hour and until at least a constant volume of water per time unit was achieved.
- At the end of the constant head test, we measured the falling head infiltration rate by shutting off the water flow and recorded the drop in water level over regular time intervals for one hour or until all of the water was completely infiltrated.

The field infiltration rate was calculated based on the final measured volume per time unit, and the surface area of the holes.

6.2 Correction Factors

The infiltration rates calculated based on field measurements are considered short-term rates and should be reduced through correction factors for design. The corrections factors account for site variability, test method, and number of locations tested, degree of long-term maintenance, and degree of influent control to prevent siltation and bio-buildup. The correction factors are outlined in Table III-3.3.1 of the 2014 DOE Manual, and are summarized and discussed below:

- **Site Variability (CF_v)** – A range of 0.33 to 1.0 is provided in the DOE manual. Based on the test pits excavated across the project alignment, the soil conditions at the site are generally consistent. In our opinion, a CF_v of 0.5 is appropriate given the relatively large spacing between our test locations.

- **Test Method (CF_t)** – The DOE Manual specifies a correction factor of 0.5 for the small PIT test method.

- **Degree of influent control to prevent siltation and bio-buildup (CF_m)** – Assuming a good degree of control, the DOE Manual recommends CF_m of 0.9. This value also assumes infiltration systems would be cleaned or maintained if they become clogged.

The Total Correction Factor (CF_T) is then calculated as: $CF_T = CF_v \times CF_t \times CF_m = 0.23$.

6.3 LONG TERM INFILTRATION RATE FOR DESIGN

With the Total Correction Factor (**CF_T**) of 0.23, the long-term design rate can be calculated from the field measured rates. Table 3, below, details the infiltration data collected and the long-term design rates calculated for each location along the project alignment.

TABLE 3: Small Pilot Infiltration Test Data Corrected for Long Term Design Rate

Test Location	Pre-Soak Duration (hrs)	Test Stage	Test Duration	Field Measured Rate (in/hr)	Correction Factor	Long Term Design Rate (in/hr)
PIT-1 at 4 feet	6	Constant Head	1 hour	222	0.23	51
		Falling Head	6 min (drained)			
PIT-2 at 4 feet	6	Constant Head	1 hour	150	0.23	35
		Falling Head	4 min (drained)			
PIT-3 at 4 feet	6	Constant Head	1 hour	210	0.23	48
		Falling Head	3.75 min (drained)			
PIT-4 at 4 feet	6	Constant Head	1 hour	64	0.23	15
		Falling Head	11 min (drained)			
PIT-5 at 4 feet	6	Constant Head	1 hour	261	0.23	60
		Falling Head	4 min (drained)			
PIT-6 at 5 feet	6	Constant Head	1 hour	72	0.23	17
		Falling Head	17 min (drained)			

The field measured infiltration rates were variable, which is expected in the shallow soils underlying the site. Based on the results of our subsurface exploration, field infiltration testing and laboratory testing, infiltration of stormwater should be feasible using the rates provided in Table 2, above.

6.4 Cation Exchange Capacity Test Results

The WDOE Manual specifies that soils used for treatment and infiltration should have a CEC of greater than or equal to 5 milliequivalents per 100 grams of dry soil (meq/100g). CEC testing was performed on 6 representative samples from our test pits. Table 4, below, provides a summary of the CEC test results. Based on review of the testing, in general, the site soils meet the minimum CEC value of 5 meq/100g required for treatment.

TABLE 4: Cation Exchange Capacity Test Results

Location	Soil Sample Depth (feet)	CEC (meq/100g)
PIT-1	4	5.58
PIT-2	4	4.79
PIT-3	1	19.8
PIT-4	4	5.07
PIT-5	4	9.09
PIT-6	3	19.7

The results of the analytical testing are provided in Appendix E.

6.5 Organic Content Test Results

Three representative samples collected from our infiltration test pits were submitted to determine the percent of organic material in the soils at our infiltration test locations. The testing procedure was performed in general accordance with the ASTM D2974-13 *Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils*. Table 5, below, provides a summary of the organic material test results.

TABLE 5: Organic Matter of Organic Soils Test Results

Location	Soil Sample Depth (feet)	Organic Content (%)
PIT-1	4	2.31
PIT-4	4	1.96
PIT-6	1.5	2.02

A summary of the analytical testing is provided in Appendix E.

6.6 Construction Considerations

Infiltration facilities are post-construction facilities which are designed to improve the quality and manage the volume of stormwater runoff by encouraging natural infiltration on-site. In order to protect the infiltration receptor soils from becoming clogged with sediment and/or becoming compacted during construction, we recommend the following measures be implemented during construction:

- The infiltration facilities should be constructed as late in the schedule as feasible and should not be constructed until after the upstream areas are stabilized.
- Heavy equipment traffic on prepared subgrades should be limited, especially during wet weather.
- If fine grained sediment is deposited or tracked onto the infiltration system subgrade, it should be removed using an excavator with a grade plate, a small dozer or a vacuum truck.
- The subgrade should be scarified prior to placing fill to prevent sealing of the receptor soils.
- Structural fill and aggregate base materials should be end-dumped at the edge of the fill area and the material pushed out over the subgrade.

- Grading of the infiltration galleries should be accomplished using low-impact earth-moving equipment to prevent compaction of the underlying soils. Wide tracked vehicles such as excavator, small dozers and bobcats are suggested.

- The infiltration system subgrade soils should be reviewed after excavation to verify the soils encountered are as anticipated.

7.0 PAVEMENTS AND SIDEWALKS

7.1 PAVEMENT DESIGN

The asphalt surface along the alignment is generally in good condition. During our field exploration, we observed little to no distress, fatigue, longitudinal/transverse cracking, or differential settlement. Asphalt patches were present in localized areas but with no area of observed distress.

7.1.1 Design Traffic Level

We were provided with a traffic study from January 2020 to use in our pavement design. Traffic counts were obtained at four locations in the study area with separate counts provided for each travelling lanes and the traffic data was broken by vehicle class. Table 6, below, provides a summary of the traffic count data.

TABLE 6: Traffic Count Summary

Location	Direction	AADT	Percent Heavy Trucks
Gravelly Lake Drive Southwest between Veterans Drive Southwest and Nyanza Road Southwest	Eastbound	10,487	4.4
	Westbound	9,421	6.4
Gravelly Lake Drive Southwest between Veterans Drive Southwest and Washington Boulevard Southwest	Northbound	6,865	7.7
	Southbound	7,709	6.5
Washington Boulevard Southwest west of Interlaken Drive Southwest	Eastbound	9,373	8.1
	Westbound	9,175	7.4
Washington Boulevard Southwest east of Edgewood Avenue Southwest	Eastbound	7,543	6.6
	Westbound	7,254	4.6

Our pavement analysis was performed using the 1993 AASHTO pavement design methodology. Our analysis included evaluating hot mix asphalt (HMA) and Portland Cement Concrete (PCC) pavement sections.

We understand that the proposed improvements are not anticipated to result in an increase in heavy truck traffic. Therefore, we did not include a factor for truck traffic growth in our analysis.

The parameters summarized in Table 7, below, were used in our design. Design is based on the traffic count data from Washington Boulevard Southwest west of Interlaken Drive Southwest.

TABLE 7: Pavement Design Parameters

Parameter	Value	
	HMA	PCC
Pavement Design life	20 years	50 years
Reliability	85%	85%
Overall Standard Deviation	0.45	0.45
Initial Serviceability	4.2	4.2
Terminal Serviceability	2.5	2.5
Design Serviceability Loss (ΔPSI)	1.7	1.7
Drainage Coefficient	1.0	1.0
Layer Coefficients:		
Hot Mix Asphalt	0.44	0.44
Asphalt Treated Base	0.23	0.23
Crushed Surfacing Base/Top Course	0.14	0.14
Design Resilient Modulus for Subgrade	25,000 psi	25,000 psi
Average Annual Daily Traffic	9,373	9,373
Percent Heavy Trucks	8.1	8.1
ESAL	2,445,000	6,625,000

The performance of the pavement designs provided below and using the design period assumed in our analysis would depend on a number of factors, including the actual traffic loading conditions and completion of regular maintenance. The recommended pavement sections will need to be revised if the traffic level, especially the percentage of heavy vehicles is significantly different from the traffic data provided and our assumptions.

7.1.2 New Asphalt Pavement Section and Subgrade Preparation

We recommend the following minimum pavement section in new pavement areas:

- Six inches of Class ½ inch Hot Mix Asphalt (HMA) over four inches crushed surfacing top/base course (CSTC/CSBC).

The asphalt binder should consist of pavement grade (PG) PG58H-22.

7.1.3 Portland Cement Concrete Pavements

We understand it is planned to use Portland cement concrete pavements at the intersection locations with traffic round-a-bouts. The recommended pavement section provided below corresponds to a 50-year pavement design life.

- Ten inches of Portland cement concrete (plain but jointed) over,
- Three inches of crushed surfacing base course.

The design is based on using concrete that will achieve a minimum compressive strength (f'_c) of 4,000 psi and a 28-day concrete modulus of rupture (S'_c) of 650 pounds per square inch (psi). The transverse joints in the pavement should be spaced 15 feet apart or less and should be in accordance with WSDOT Standard Specifications for Road, Bridge and Municipal Construction (WSDOT, 2020).

7.1.4 Subgrade Preparation

In new pavement areas, we anticipate the pavement subgrade will consist of silty fine to coarse sand with gravel and cobbles.

Site preparation for new pavement areas should begin with removal of the existing pavements, topsoil, vegetation, roots, debris, deleterious material, and unsuitable soil from the area of the proposed improvements and excavating to the design subgrade elevation, where applicable.

Soft or yielding areas or organic-rich soils identified during the compaction process should be over-excavated and backfilled with properly compacted CSBC, as described in Section 9-03.9(3) of the WSDOT *Standard Specifications*, or gravel borrow as described in Section 9-03.14 (1) of the *Standard Specifications (WSDOT, 2020)*. The subgrade preparation should be observed by an individual experienced with earthwork construction, to verify the adequacy of the prepared subgrade.

7.1.5 Mill and Overlay Pavement Section

In our opinion, if feasible, the existing pavement may be incorporated into the final design of the project by conducting a shallow mill of the existing pavement surface and then placing an overlay. Based on the 30-year design life we recommend the following pavement section in areas where a grind and overlay are feasible:

- Mill and remove the top one inch of the existing asphalt and place a three-inch thick overlay of Class ½-inch HMA.

The overlay should be bonded to the milled surface by applying a tack coat, per the WSDOT recommendations. The entire milled pavement surface should be cleaned prior to placement of the tack coat. The tack coat should not be applied in cold or wet weather, or when wet weather is forecasted prior to placement of the overlay. Before the application of the tack coat, all cracks greater than ¼ inch in width should be cleaned and sealed.

7.1.6 Placement of HMA

Placement of HMA should be in accordance with Section 5-04 of the WSDOT *Standard Specifications for Road and Bridge Construction* (WSDOT, 2020).

7.1.7 Pavement Surface Drainage

Wherever possible, the pavement surface should be sloped to provide drainage of surface water to the storm drain system. Wherever possible, the grades along each side of the alignments should be sloped so surface water will drain away from the pavement. Water that ponds on or adjacent to pavement surfaces could penetrate or seep under the pavement, saturate the subgrade and contribute to premature pavement deterioration.

7.1.8 Maintenance

The new asphalt pavements will wear and eventually crack. It should be anticipated that a functional overlay will be required between 20 and 30 years.

Cracking in asphalt pavement is typical and should be expected over the life of the pavement. These require routine maintenance to prevent accelerated deterioration. Accordingly, it is highly recommended to establish a maintenance program where the cracks are routinely filled as they appear beginning at about the second year of life. It is also recommended that surface fog seal coats be considered beginning at about year 5 and every 5 years after. This will help preserve the pavements, extending the service life.

7.2 SIDEWALKS

The near-surface soils along the alignment are considered adequate for supporting new sidewalks. Prior to sidewalk construction, any deleterious and organic-rich soils should be removed from within the footprint of the sidewalk. To provide a level and firm surface for sidewalk construction, we recommend a leveling course consists of at least 2 inches of Crushed Surfacing Top Course (CSTC) compacted to a dense condition be placed directly below concrete sidewalks to provide a level and firm uniform support.

7.3 GRAVITY RETAINING WALLS

Gravity retaining walls are planned for the southeast and southwest corners of the intersection of Alameda Drive Southwest and Washington Boulevard Southwest and Interlaaken Drive Southwest and Washington Boulevard Southwest. The walls will be constructed against both cut and fill sections. We understand it is planned to use pre-cast concrete blocks with typical dimensions ranging from 2 to 2½ feet high by 2 to 2½ feet wide by four to five feet long Blocks for the gravity walls.

> ***Minimum Width*** – In general, as a minimum, all concrete blocks should have a minimum width equal to the greater of 2 feet or one-third the wall height. For walls with a retained height greater than four feet, we recommend the bottom row of blocks be rotated 90 degrees, so the long axis of the blocks is perpendicular to the wall face.

Minimum Embedment – Walls constructed with a level fore slope should have a minimum of 6-inches of embedment. All walls should be founded on competent native soils or structural fill.

Foundation Preparation – The foundation bearing soils should be compacted to a firm and unyielding condition prior to placing the initial course of blocks. To provide a firm and uniform support for the walls, a 6-inch thick layer of Crushed Surfacing Top or Base Course (CSTC or CSBC, WSDOT 9-03.9(3)) or an approved equivalent should be placed as a leveling course.

Surcharge - Lateral pressures from surface surcharges located within a distance equal to the exposed wall height should be estimated using a lateral pressure coefficient of 0.3 (i.e. the ratio of lateral pressure to vertical pressure). Where applicable, a lateral uniform pressure of 80 psf should be used to account for traffic surcharge.

Geotechnical Design Parameters – We recommend the following geotechnical parameters be used for design of gravity walls:

- Active Earth Pressure: 35 pcf
- Allowable Passive Pressure: 350 pcf
- Seismic Lateral Earth Pressure 7H (where H is the height of the wall)
- Allowable Friction Coefficient: 0.35
- Allowable Bearing Capacity: 3,000 psf

8.0 LIGHT AND SIGNAL POLE FOUNDATION

The soil conditions encountered in our test borings and test pits are considered adequate for supporting the pole foundations using WSDOT standards. For design purposes, a lateral bearing capacity of 2,500 psf may be used in design calculations. A soil friction angle of 34 degrees is considered appropriate for evaluating the shaft friction for torsional resistance.

The site soils are prone to sloughing and caving. Depending on the foundation design, the use of temporary casing or temporary shoring may be needed in order to maintain the stability of the foundation excavation.

9.0 EARTHWORK CONSIDERATIONS

9.1 SITE PREPARATION FOR NEW PAVEMENT AREAS

Site preparation for new pavement areas should begin with removal of existing vegetation, pavement, underground utilities to be abandoned, deleterious material, and unsuitable soil from the area of the proposed improvements and excavating to the design subgrade elevation, where applicable.

9.2 TEMPORARY EXCAVATIONS

Temporary excavations should be made in accordance with Part N of WAC (Washington Administrative Code) 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring. It is contractor's responsibility to maintain safe working conditions, including temporary excavation stability and, if needed, dewatering.

Based on the encountered coarse, granular soils underlying the project area, temporary excavations should be inclined no steeper and 1½H:1V (Horizontal:Vertical). Temporary excavations should be evaluated in the field during construction based on actual observed soil conditions. If seepage is encountered, temporary excavation slope inclinations may need to be reduced. During wet weather, the cut slopes may need to be flattened to reduce potential erosion or should be covered with plastic sheeting.

9.3 UNDERGROUND UTILITIES

Underground utilities planned as part of the road improvements can be installed using conventional excavation methods. Excavations in excess of 4 feet in depth should be sloped in accordance with the recommendations in Section 8.2 of this study.

9.3.1 Pipe Support and Bedding

Utility installation should be conducted in accordance with the 2020 WSDOT Standard Specifications or other applicable specifications for placement and compaction of pipe bedding and backfill. In general, pipe bedding should be placed in loose lifts not exceeding 6 inches in thickness and compacted to a firm and unyielding condition. Bedding materials and thicknesses provided should be suitable for the utility system and materials installed, and in accordance with any applicable manufacturers' recommendations. Pipe bedding materials should be placed on relatively undisturbed native soil.

Based on our field explorations, we anticipate relatively coarse-grained soils comprised of poorly graded gravel with cobbles. Some overexcavation and removal of cobbles should be anticipated at the pipe invert elevation to maintain a uniform grade for the utility installation. Where overexcavation is needed, additional pipe bedding should be placed to restore the grade.

9.3.2 Trench Backfill

Utility trench backfill is a primary concern in reducing the potential for settlement along utility alignments, particularly in pavement areas. It is important that each section of utility line be adequately supported in the bedding material. The material should be hand tamped to ensure support is provided around the pipe haunches.

The onsite sand/gravel may be used as trench backfill, provided cobbles larger than 6 inches in diameter are screened and removed prior to backfill.

Fill should be carefully placed and hand tamped to about 12 inches above the crown of the pipe before heavy compaction equipment is brought into use. The trench backfill should be placed in 8- to 12-inch thick loose lifts and compacted to at least 95 percent maximum dry density, per ASTM D1557 *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.*

In order to reduce the potential for damaging the utilities, heavy compaction equipment should not be permitted to operate directly over utilities until a minimum of two feet of backfill has been placed.

9.4 Structural Fill and Compaction

Structural fill should be properly moisture conditioned, placed in loose, horizontal lifts less than 8 inches in thickness, and compacted to at least 95 percent maximum density, determined using ASTM D 1557 (Modified Proctor). The procedure to achieve proper density of a compacted fill depends on the size and type of compacting equipment, the number of passes, thickness of the lifts being compacted, and certain soil properties. If the excavation is constricting and restricts the use of heavy equipment, smaller equipment can be used, but the lift thickness will need to be reduced to achieve the required relative compaction.

Generally, loosely compacted soils are a result of poor construction technique or improper moisture content. Soils with high fines contents are particularly susceptible to becoming too wet and coarse-grained materials easily become too dry, for proper compaction. Silty or clayey soils with a moisture content too high for adequate compaction should be dried as necessary, or moisture conditioned by mixing with drier materials, or other methods.

9.5 Material Reuse

The native silty fine to coarse sand with gravel and fine to coarse gravel with cobbles can be used as structural fill, provided they are free of topsoil and organics and cobbles larger than six inches in diameter are screened and removed. If use of the native soil is planned, the excavated soil should be stockpiled and protected with plastic sheeting to prevent it from becoming saturated by precipitation or runoff.

9.6 Permanent Cut and Fill Slopes

Based on the anticipated soil that will be exposed in the planned excavation, we recommend permanent cut and fill slopes be constructed no steeper than 2H:1V (Horizontal:Vertical). Cut slopes should be observed by a qualified professional during excavation to verify that conditions are as anticipated. Supplementary recommendations can then be developed, if needed, to improve stability, including flattening of slopes or installation of surface or subsurface drains.

Permanently exposed slopes should be seeded with an appropriate species of vegetation to reduce erosion and improve stability of the surficial layer of soil.

9.7 Wet Weather Construction

General recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. The following procedures are best management practices recommended for use in wet weather construction:

- Earthwork should be performed in small areas to minimize subgrade exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement and compaction of clean structural fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance.

- During wet weather, the allowable fines content of the structural fill should be reduced to no more than 5 percent by weight based on the portion passing the 0.75-inch sieve. The fines should be non-plastic.

- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water.

- Soils stockpiled on site should be covered with plastic sheeting.

9.8 Erosion Considerations

Surface runoff can be controlled during construction by careful grading practices using the erosion control measures on the civil drawings.

Permanent control of surface water should be incorporated into the final grading design. Adequate surface gradients and drainage systems should be incorporated into the design such that surface runoff is collected and directed away from improved areas and discharged to a suitable outlet. Potential issues associated with erosion may also be reduced by establishing vegetation within disturbed areas immediately following grading operations.

10.0 LIMITATIONS

We have prepared this report for Parametrix, Inc. and the project design team. Recommendations contained in this report are based on a site reconnaissance, a subsurface exploration program, review of pertinent subsurface information, and our understanding of the project. The study was performed using a mutually agreed-upon scope of work.

Variations in soil conditions may exist between the locations of the explorations and the actual conditions underlying the site. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at the site that are different from those described in this report, we should be notified immediately to review the applicability of our recommendations. Additionally, we should also be notified to review the applicability of our recommendations if there are any changes in the project scope.

The scope of our work does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractors' methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design. Additionally, the scope of our work specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances.

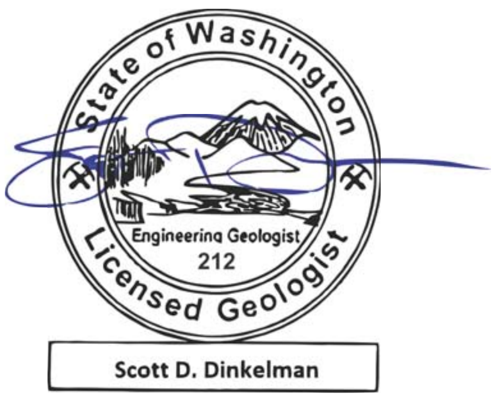
This report has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or other factors including advances in our understanding of applied science, may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 24 months from its issuance. PanGEO should be notified if the project is delayed by more than 24 months from the date of this report so that we may review the applicability of our conclusions considering the time lapse.

It is the client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk. Any party other than the client who wishes to use this report shall notify PanGEO of such intended use and for permission to copy this report. Based on the intended use of the report, PanGEO may require that additional work be performed and that an updated report be reissued. Noncompliance with any of these requirements will release PanGEO from any liability resulting from the use this report.

We appreciate the opportunity to be of service.

Sincerely,



Scott D. Dinkelman, LEG
Principal Engineering Geologist

Siew L. Tan, P. E.
Principal Geotechnical Engineer

11.0 LIST OF REFERENCES

American Association of State Highway and Transportation Officials, 1993, *AASHTO Guide for Design of Pavement Structures*.

ASTM D1557, 2012, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))*, ASTM International, West Conshohocken, PA www.astm.org

ASTM D1586, 2011, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*, ASTM International, West Conshohocken, PA, www.astm.org.

ASTM D2488, 2017, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)*, ASTM International, West Conshohocken, PA, www.astm.org.

ASTM D2974, 2014, *Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils*, ASTM International, West Conshohocken, PA, www.astm.org.

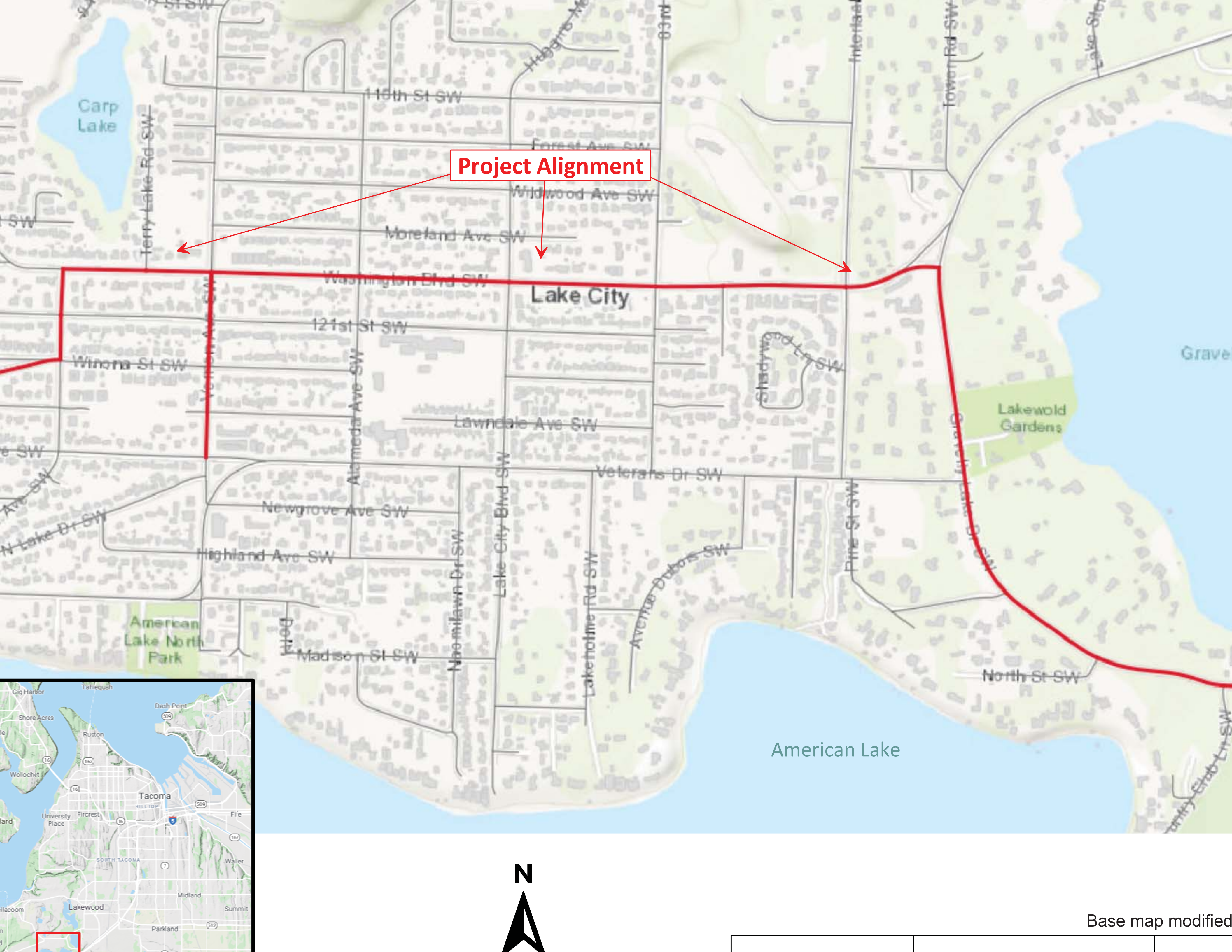
Schuster, J.E., Cabibbo, A.A., Schilter, J.F., Hubert, I.J., 2015, *Geologic Map of the Tacoma 1:100,000-Scale Quadrangle, Washington.* Washington Division of Geology and Earth Resources. Map Series 2019-03, scale 1:100,000.

Wood, 2019, Geotechnical Report titled Veterans Drive Southwest Redevelopment, Lakewood, Washington. Consultant report prepared for Parametrix.

Washington State Department of Ecology, 2014, *Stormwater Management Manual for Western Washington* Publication.

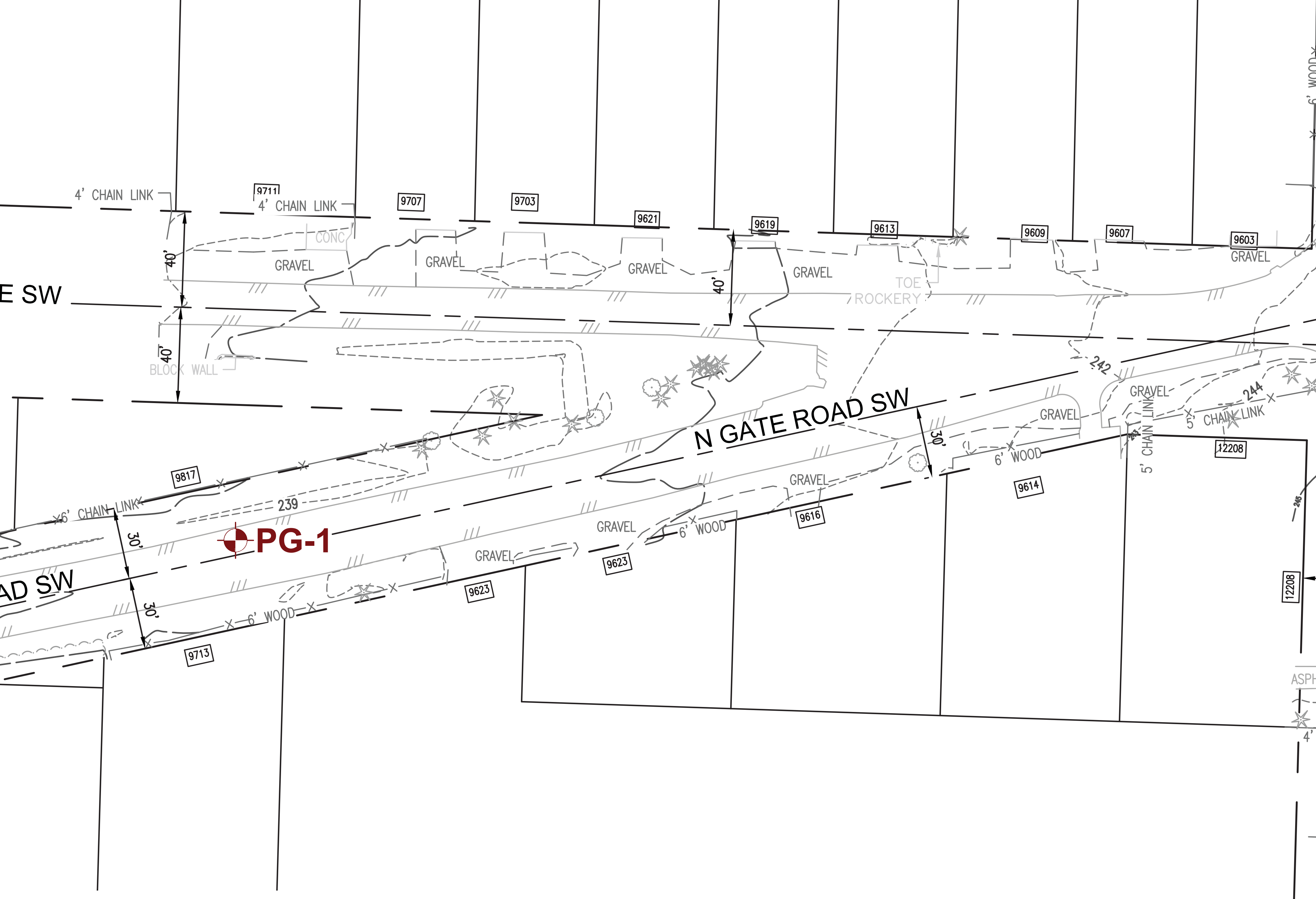
WSDOT, 2011, *WSDOT Pavement Policy,* Washington State Department of Transportation.

WSDOT, 2020, *Standard Specifications for Road, Bridge and Municipal Construction, M 41-10.*



Base map modified

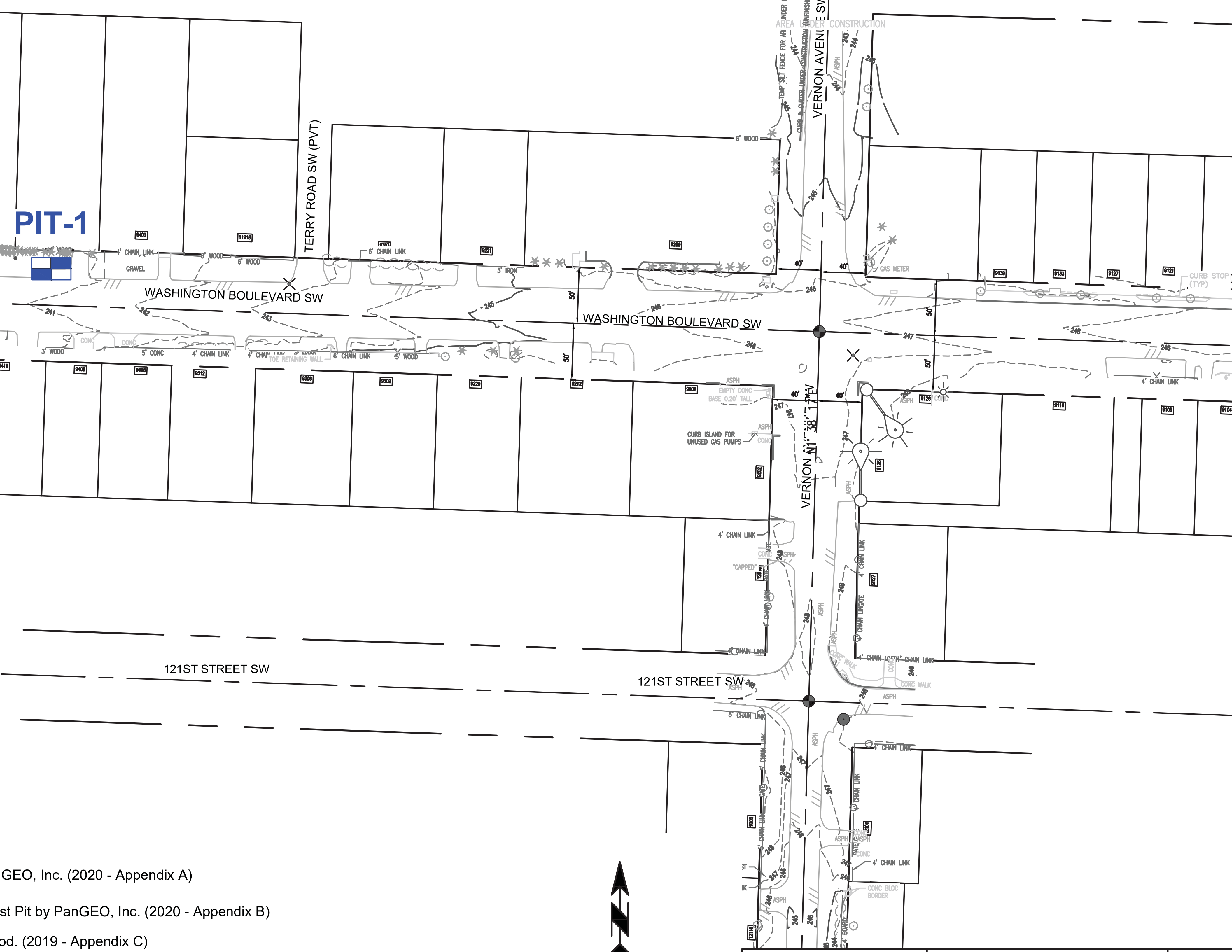

Figure 3B
Figure 3C
Figure 3D
Figure 3E
Figure 3F
Figure 3G
PG-2
PG-3
PG-4
PG-5
PG-6
PG-7
B-8
PIT-2
PIT-3
PIT-4
PIT-5
Washington Blvd SW
Gravelly Lake Dr SW
Veterans Dr SW
Lake City Blvd SW
Lakewold Gardens
American Lake North Park
American Lake
-122.560
-122.555
-122.550
-122.545
-122.540
-122.535
GEO, Inc. (2020 - Appendix A)
st Pit by PanGEO, Inc. (2020 - Appendix B)
od. (2019 - Appendix C)
© 2020 Microso

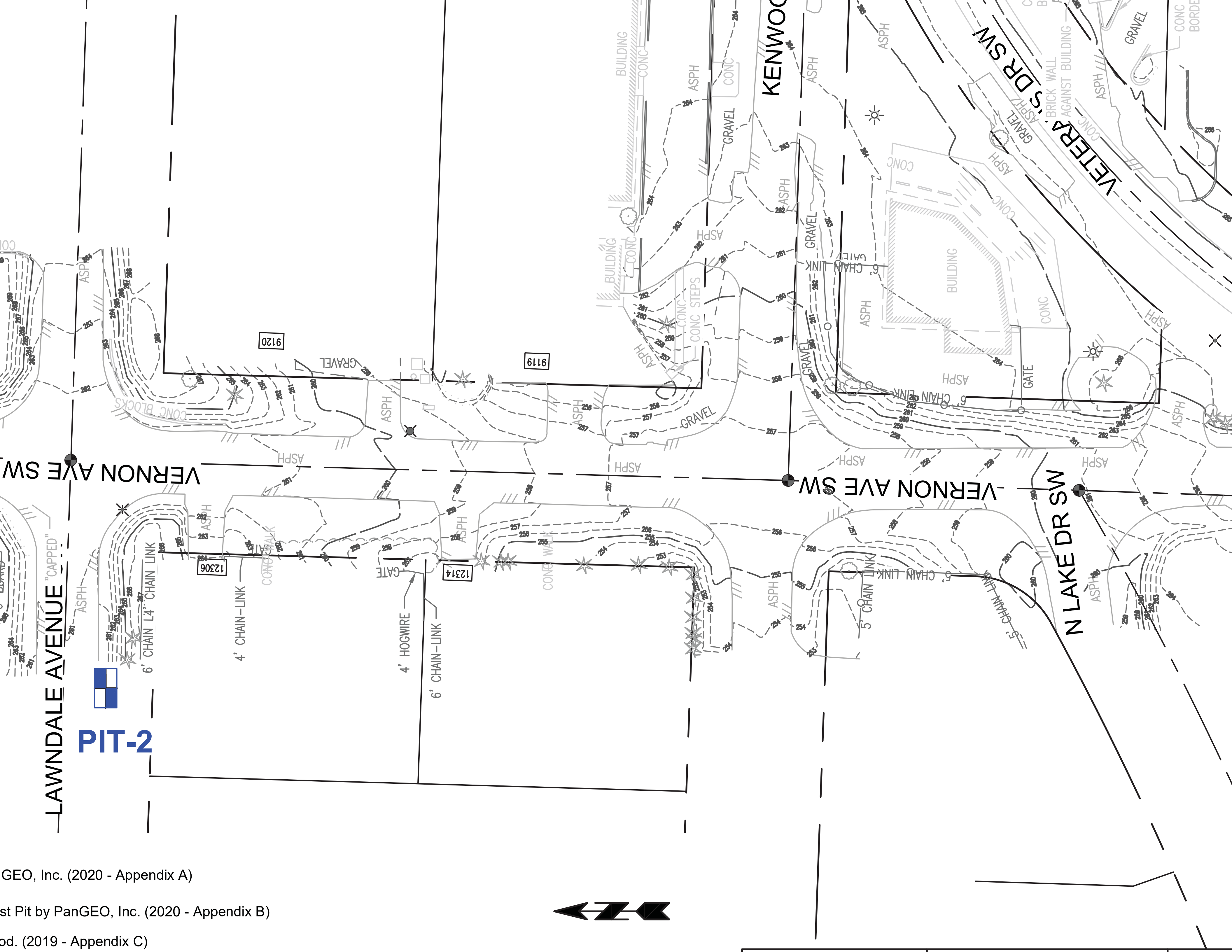


nGEO, Inc. (2020 - Appendix A)

st Pit by PanGEO, Inc. (2020 - Appendix B)

od. (2019 - Appendix C)

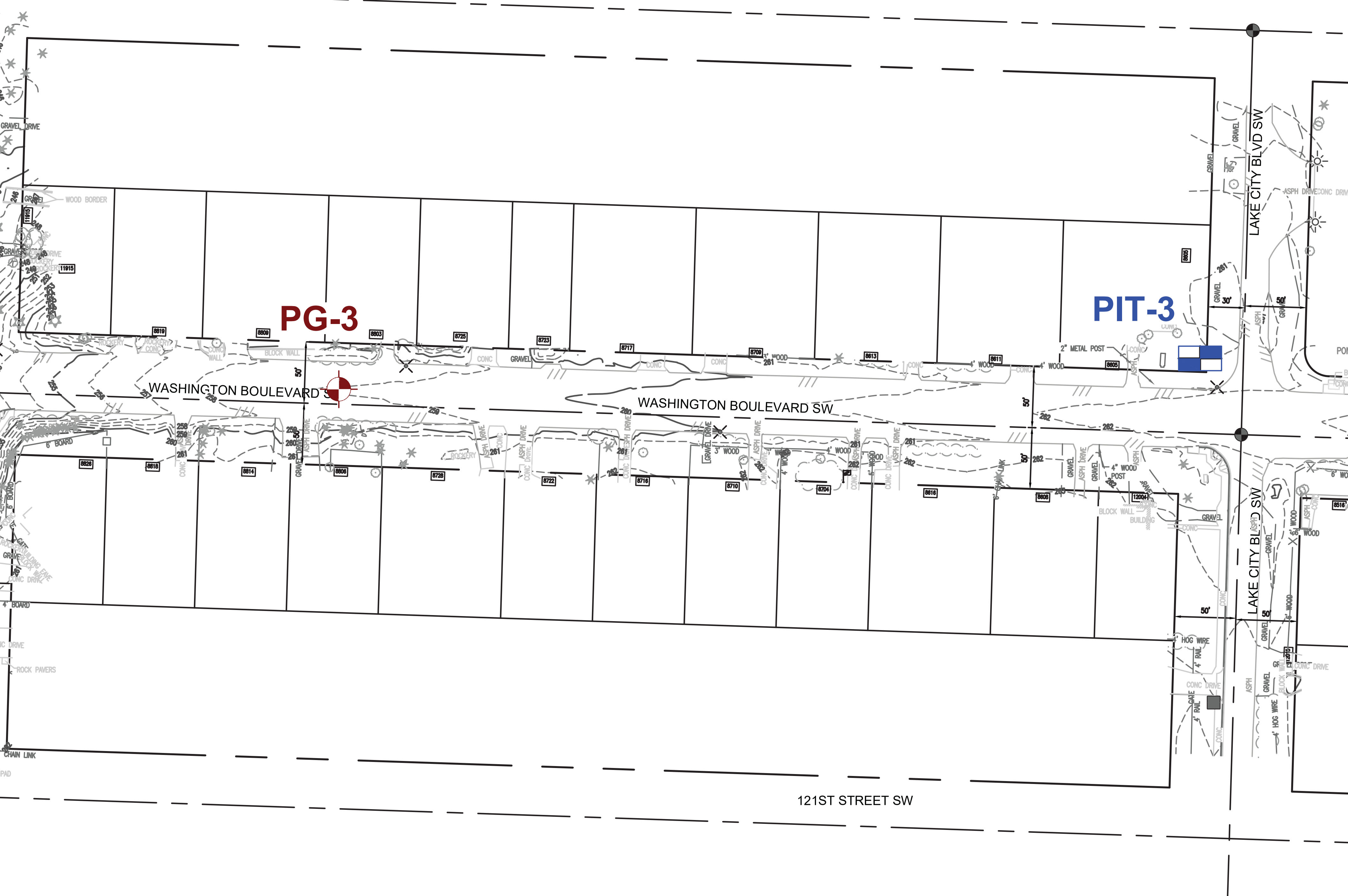

PIT-1
WASHINGTON BOULEVARD SW
TERRY ROAD SW (PVT)
VERNON AVENUE SW
121ST STREET SW
AREA UNDER CONSTRUCTION
GAS METER
CURB STOP (TYP)
CURB ISLAND FOR UNUSED GAS PUMPS
EMPTY CONC BASE 0.20' TALL
TOE RETAINING WALL
"CAPPED"
CONC BLOC BORDER
N1° 38' 17" E
GEO, Inc. (2020 - Appendix A)
st Pit by PanGEO, Inc. (2020 - Appendix B)
od. (2019 - Appendix C)



GEO, Inc. (2020 - Appendix A)

st Pit by PanGEO, Inc. (2020 - Appendix B)

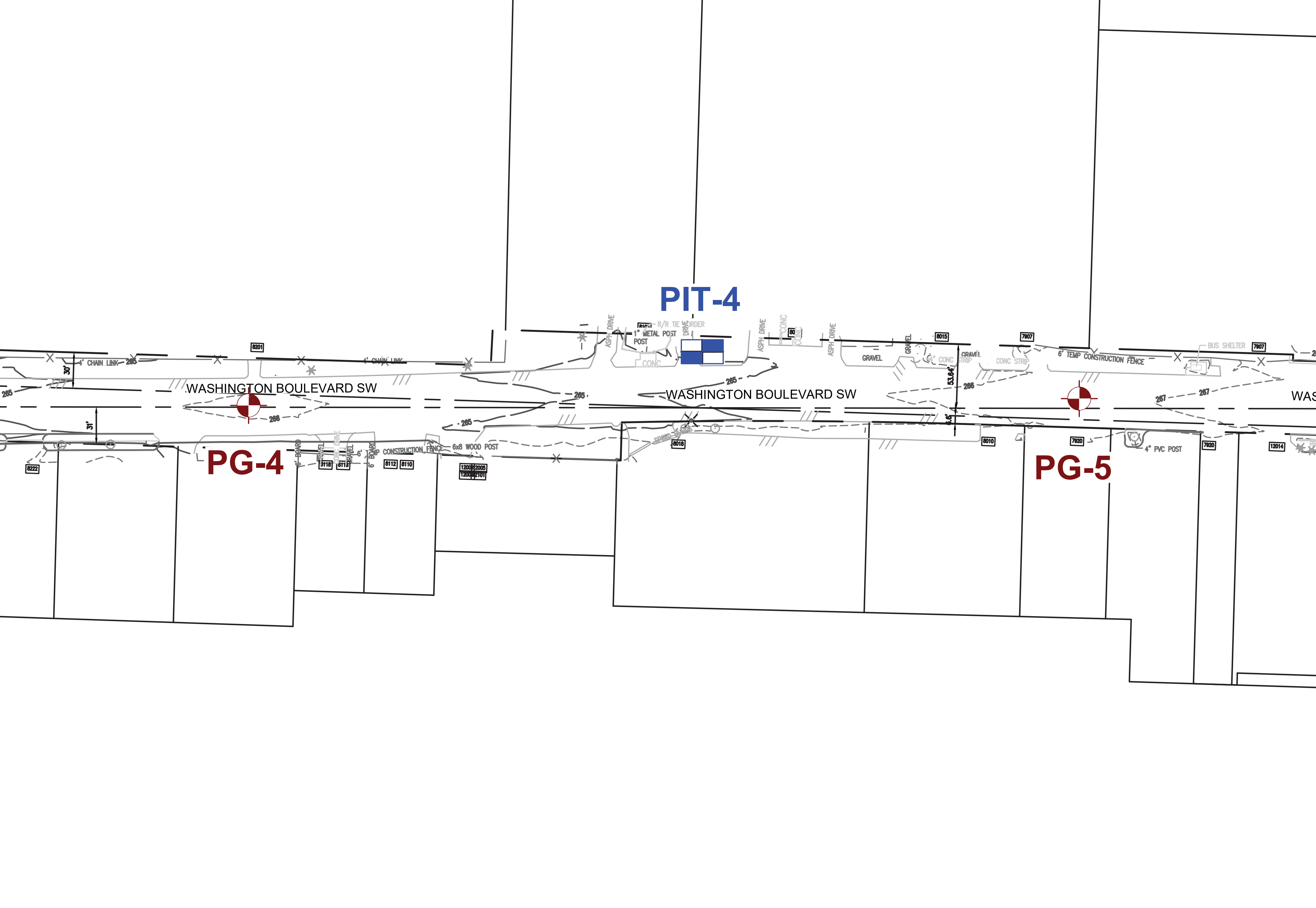
od. (2019 - Appendix C)



GEO, Inc. (2020 - Appendix A)

st Pit by PanGEO, Inc. (2020 - Appendix B)

od. (2019 - Appendix C)



GEO, Inc. (2020 - Appendix A)

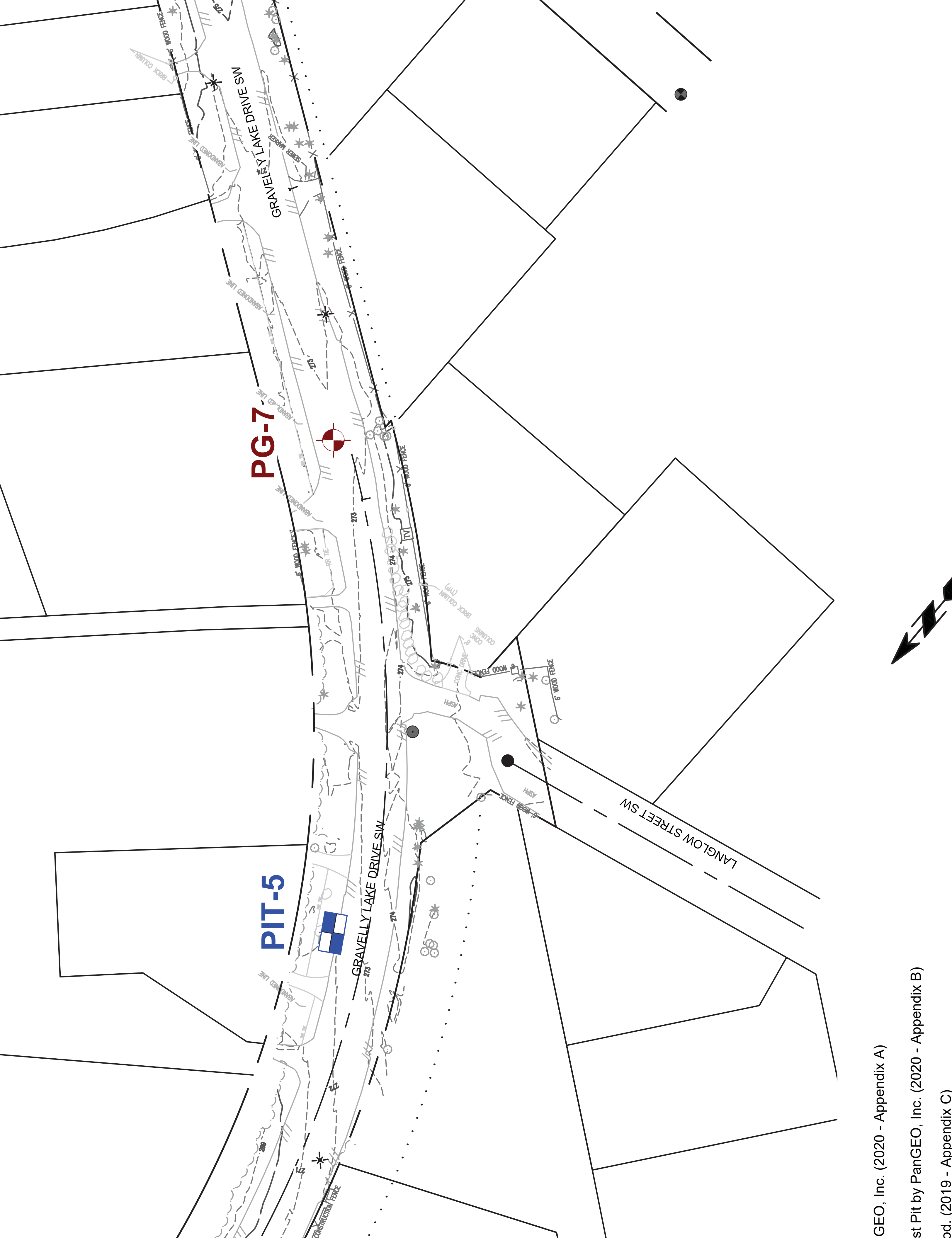
st Pit by PanGEO, Inc. (2020 - Appendix B)

od. (2019 - Appendix C)

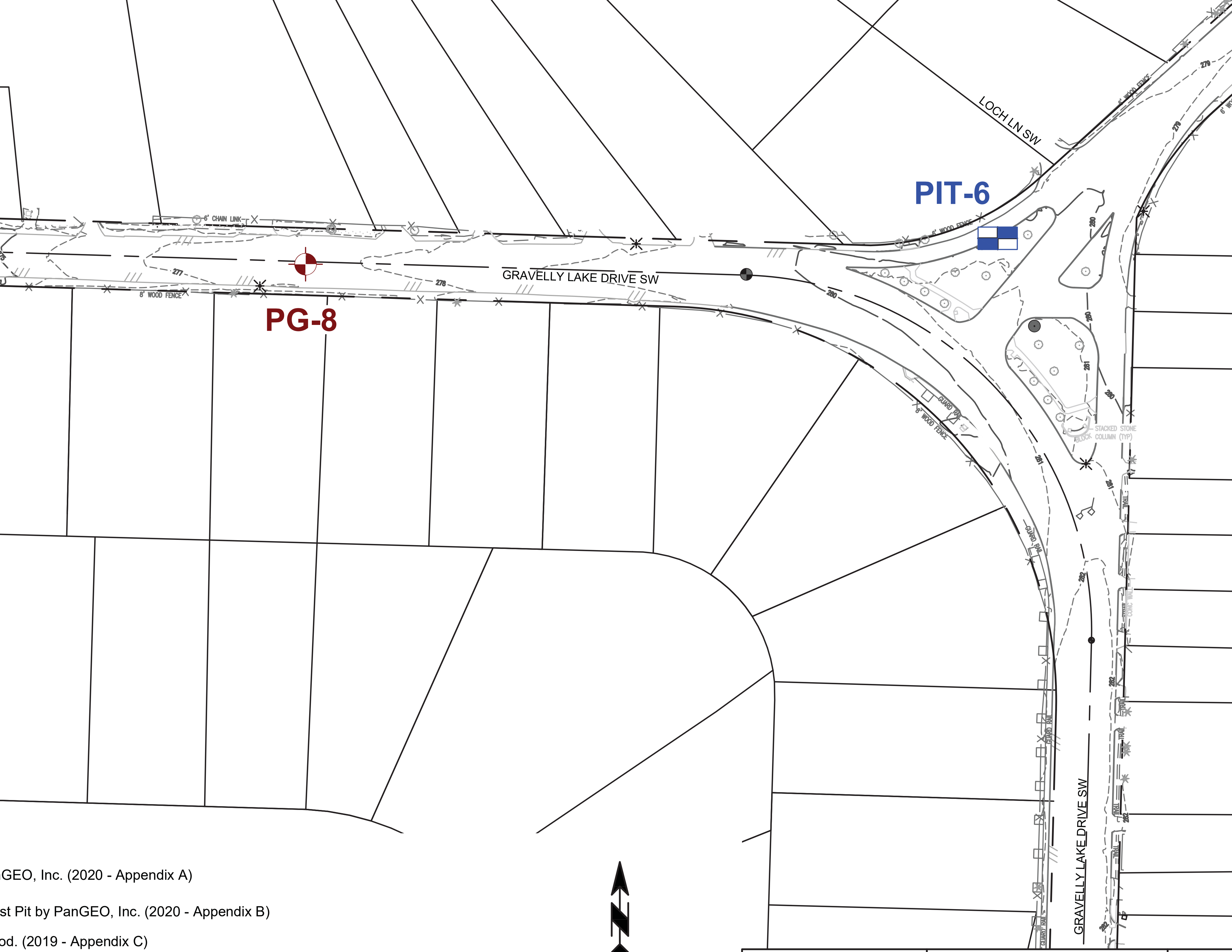
GEO, Inc. (2020 - Appendix A)

st Pit by PanGEO, Inc. (2020 - Appendix B)

od. (2019 - Appendix C)



GEO, Inc. (2020 - Appendix A)
st Pit by PanGEO, Inc. (2020 - Appendix B)
od. (2019 - Appendix C)


PIT-6
PG-8
LOCH LN SW
GRAVELLY LAKE DRIVE SW
GRAVELLY LAKE DRIVE SW
GEO, Inc. (2020 - Appendix A)
st Pit by PanGEO, Inc. (2020 - Appendix B)
od. (2019 - Appendix C)

APPENDIX A

SUMMARY BORING LOGS

RELATIVE DENSITY / CONSISTENCY

SAND / GRAVEL			SILT / CLAY		
Density	SPT N-values	Approx. Relative Density (%)	Consistency	SPT N-values	Approx. Undrained Shear Strength (psf)
Very Loose	<4	<15	Very Soft	<2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Med. Dense	10 to 30	35 - 65	Med. Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	>50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	>30	>4000

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		GROUP DESCRIPTIONS	
Gravel 50% or more of the coarse fraction retained on the #4 sieve. Use dual symbols (eg. GP-GM) for 5% to 12% fines.	GRAVEL (<5% fines)	GW	Well-graded GRAVEL
		GP	Poorly-graded GRAVEL
	GRAVEL (>12% fines)	GM	Silty GRAVEL
		GC	Clayey GRAVEL
Sand 50% or more of the coarse fraction passing the #4 sieve. Use dual symbols (eg. SP-SM) for 5% to 12% fines.	SAND (<5% fines)	SW	Well-graded SAND
		SP	Poorly-graded SAND
	SAND (>12% fines)	SM	Silty SAND
		SC	Clayey SAND
Silt and Clay 50%or more passing #200 sieve	Liquid Limit < 50	ML	SILT
		CL	Lean CLAY
		OL	Organic SILT or CLAY
	Liquid Limit > 50	MH	Elastic SILT
		CH	Fat CLAY
		OH	Organic SILT or CLAY
Highly Organic Soils		PT	PEAT

Notes:
1. Soil exploration logs contain material descriptions based on visual observation and field tests using a system modified from the Uniform Soil Classification System (USCS). Where necessary laboratory tests have been conducted (as noted in the "Other Tests" column), unit descriptions may include a classification. Please refer to the discussions in the report text for a more complete description of the subsurface conditions.

2. The graphic symbols given above are not inclusive of all symbols that may appear on the borehole logs. Other symbols may be used where field observations indicated mixed soil constituents or dual constituent materials.

DESCRIPTIONS OF SOIL STRUCTURES

Layered:	Units of material distinguished by color and/or composition from material units above and below
Laminated:	Layers of soil typically 0.05 to 1mm thick, max. 1 cm
Lens:	Layer of soil that pinches out laterally
Interlayered:	Alternating layers of differing soil material
Pocket:	Erratic, discontinuous deposit of limited extent
Homogeneous:	Soil with uniform color and composition throughout
Fissured:	Breaks along defined planes
Slickensided:	Fracture planes that are polished or glossy
Blocky:	Angular soil lumps that resist breakdown
Disrupted:	Soil that is broken and mixed
Scattered:	Less than one per foot
Numerous:	More than one per foot
BCN:	Angle between bedding plane and a plane normal to core axis

COMPONENT DEFINITIONS

COMPONENT	SIZE / SIEVE RANGE	COMPONENT	SIZE / SIEVE RANGE
Boulder:	> 12 inches	Sand	
Cobbles:	3 to 12 inches	Coarse Sand:	#4 to #10 sieve (4.5 to 2.0 mm)
Gravel		Medium Sand:	#10 to #40 sieve (2.0 to 0.42 mm)
Coarse Gravel:	3 to 3/4 inches	Fine Sand:	#40 to #200 sieve (0.42 to 0.074 mm)
Fine Gravel:	3/4 inches to #4 sieve	Silt	0.074 to 0.002 mm
		Clay	<0.002 mm

TEST SYMBOLS

for In Situ and Laboratory Tests listed in "Other Tests" column.

ATT	Atterberg Limit Test
Comp	Compaction Tests
Con	Consolidation
DD	Dry Density
DS	Direct Shear
%F	Fines Content
GS	Grain Size
Perm	Permeability
PP	Pocket Penetrometer
R	R-value
SG	Specific Gravity
TV	Torvane
TXC	Triaxial Compression
UCC	Unconfined Compression

SYMBOLS

Sample/In Situ test types and intervals

- 2-inch OD Split Spoon, SPT (140-lb. hammer, 30" drop)
- 3.25-inch OD Spilt Spoon (300-lb hammer, 30" drop)
- Non-standard penetration test (see boring log for details)
- Thin wall (Shelby) tube
- Grab
- Rock core
- Vane Shear

MONITORING WELL

- Groundwater Level at time of drilling (ATD)
- Static Groundwater Level
- Cement / Concrete Seal
- Bentonite grout / seal
- Silica sand backfill
- Slotted tip
- Slough
- Bottom of Boring

MOISTURE CONTENT

Dry	Dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

LOG KEY 09-118 LOG.GPJ PANGEO.GDT 11/12/13

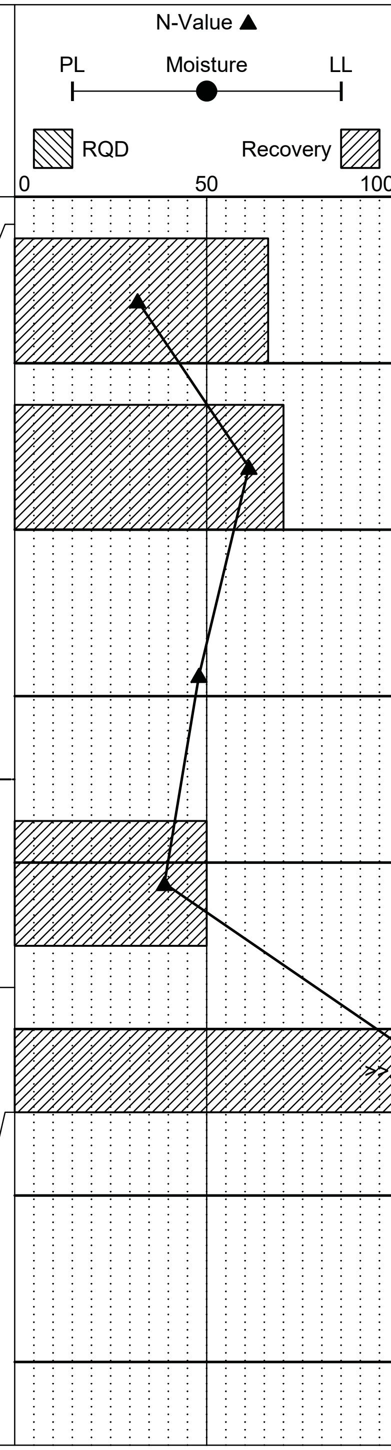
PanGEO INCORPORATED
Phone: 206.262.0370

Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project:	JBLM North Access Improvement Project	Surface Elevation:	Approx. 235 feet
Job Number:	20-024	Top of Casing Elev.:	
Location:	Lakewood, WA	Drilling Method:	TD-85 trailer-mounted drill, hollow stem auger
Coordinates:	Northing: 47.146512, Easting: -122.565765	Sampling Method:	Modified California (non-standard)

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Approximately 4 inches of asphalt pavement. No obvious signs of layering.
	S-1		16, 18, 14			**FILL - Hf** Dense, dark brown, silty fine to coarse SAND with gravel: damp to moist, non-plastic fines, sub-angular to sub-rounded gravel, disrupted soil structure.
2	S-2		17, 30, 31			*-- Slight increase in gravel size and fraction with depth. Intermixed distinct layers of light and dark brown observed in cuttings and sampler. Blowcounts may be overstated due to the presence of gravel.*
4						
6	S-3		14, 22, 26			*-- No recovery. Scattered 3- to 6 inch sized, subrounded cobbles returning to the service. Description based on visual observation of soil cuttings and drilling action.*
8	S-4		20, 23, 16			**WEATHERED STEILACOOM GRAVEL - Qposg** Dense, medium brown, slightly silty, medium to coarse SAND with gravel; moist, non-plastic fines, sub-angular fine and coarse gravel, homogenous color and soil structure. *-- Abundant 3- to 8-inch sized subrounded cobbles observed returning to the surface. The soil captured within the sampler may not be representative of the soil unit due to the limited size of the opening. Likewise, the blowcounts may be overstated..*
10	S-5		28, 50/5			**STEILACOOM GRAVEL - Qposg** Very dense, greyish brown, sandy GRAVEL with some silt and abundant COBBLES; moist, non-plastic fines, sub-angular fine and coarse gravel, and 3- to 8-inch sized subrounded cobbles. *-- Blowcounts may be overstated due to the presence of gravel and cobbles.*
12						Boring terminated approximately 11 feet below the road surface. Obvious signs of groundwater or groundwater seepage was not observed at the time of drilling.
14						



Completion Depth:	11.0ft
Date Borehole Started:	2/12/20
Date Borehole Completed:	2/12/20
Logged By:	N. Weikel
Drilling Company:	Boretec 1, Inc.

Remarks: Modified California (MC) sampler driven with a 140 lb. safety hammer w/30" drop. Hammer operated with a rope and cathead mechanism. Coordinates and elevation are approximate and based on their relative location to known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: WGS84 / NAVD88**

PanGEO INCORPORATED

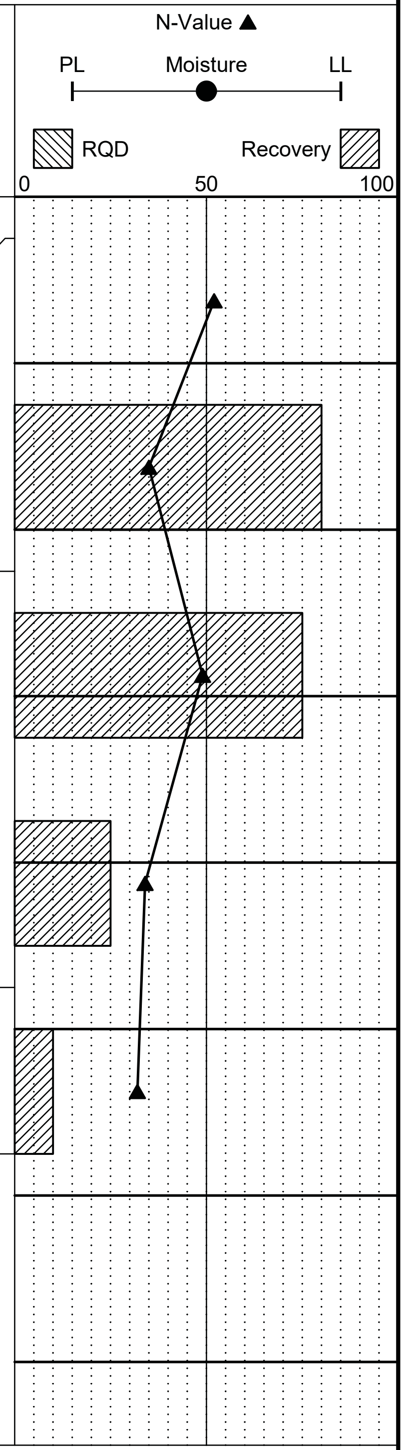
LOG OF TEST BORING PG-1

Figure A-2

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	JBLM North Access Improvement Project	Surface Elevation:	Approx. 244 feet
Job Number:	20-024	Top of Casing Elev.:	
Location:	Lakewood, WA	Drilling Method:	TD-85 trailer-mounted drill, hollow stem auger
Coordinates:	Northing: 47.148548, Easting: -122.55781	Sampling Method:	Modified California (non-standard)

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Approximately 6 inches of asphalt pavement. No obvious signs of layering.
	S-1		32, 30, 22			**FILL / DISTURBED NATIVE - Hf** Very dense, greyish-brown, silty fine to coarse SAND with abundant gravel: damp to moist, non-plastic fines, sub-angular to well-rounded gravel, disrupted soil structure. *-- No recovery with STP sampler. Switching to non-standard Modified California Sampler. Description based on visual observation of soil cuttings and drilling action. Blowcounts may be overstated.*
2	S-2		17, 18, 17			*-- Slight increase in gravel size and fraction with depth. The soil captured within the sampler may not be representative of the soil unit due to the limited size of the opening. Blowcounts may be overstated due to the presence of gravel.*
4						**WEATHERED STEILACOOM GRAVEL - Qposg** . Dense, greyish-brown with faint iron-oxide,staining, silty, medium to coarse SAND with abundant gravel; moist, non-plastic fines, sub-angular fine and coarse gravel, uniform soil structure.
6	S-3		17, 20, 29			*-- Gradual increase in gravel fraction and small cobbles observed returning to the surface with depth.*
8	S-4		8, 18, 16			*-- Becomes medium dense and moist. The soil captured within the sampler may not be representative of the soil unit due to the limited size of the opening. Likewise, the blowcounts may be overstated..*
10	S-5		10, 18, 14			**STEILACOOM GRAVEL - Qposg** Medium dense, greyish brown, sandy GRAVEL with some silt and abundant COBBLES; moist, non-plastic fines, sub-angular fine and coarse gravel, and 3- to 8-inch sized subrounded cobbles. *-- Blowcounts may be overstated due to the presence of gravel and cobbles.*
12						Boring terminated approximately 11.5 feet below the road surface. Obvious signs of groundwater or groundwater seepage was not observed at the time of drilling.
14						



Completion Depth:	11.5ft
Date Borehole Started:	2/12/20
Date Borehole Completed:	2/12/20
Logged By:	N. Weikel
Drilling Company:	Boretec 1, Inc.

Remarks: Modified California (MC) sampler driven with a 140 lb. safety hammer w/30" drop. Hammer operated with a rope and cathead mechanism. Coordinates and elevation are approximate and based on their relative location to known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: WGS84 / NAVD88**

PanGEO INCORPORATED

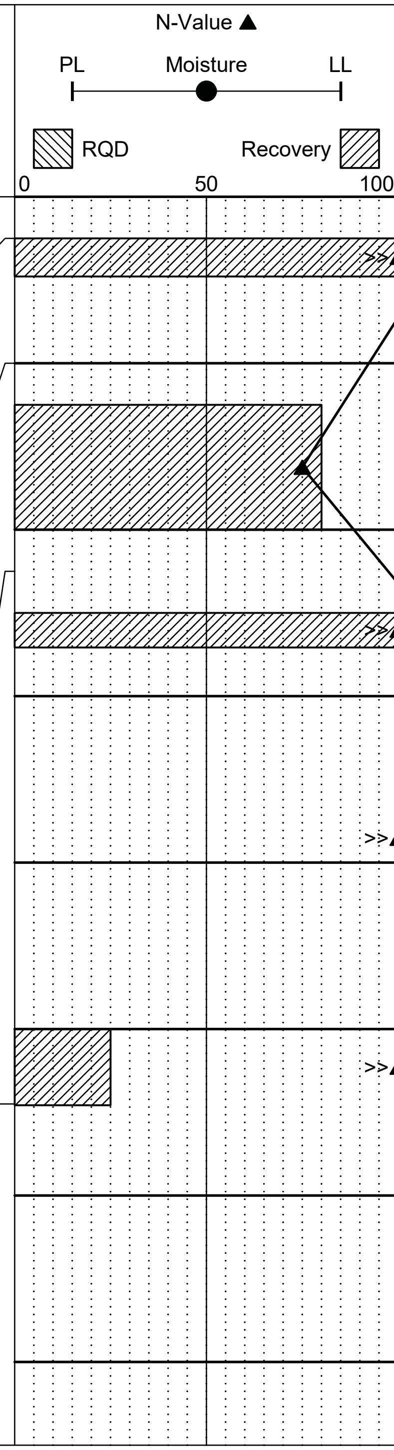
LOG OF TEST BORING PG-2

Figure A-3

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	JBLM North Access Improvement Project	Surface Elevation:	Approx. 256 feet
Job Number:	20-024	Top of Casing Elev.:	
Location:	Lakewood, WA	Drilling Method:	TD-85 trailer-mounted drill, hollow stem auger
Coordinates:	Northing: 47.148531, Easting: -122.554318	Sampling Method:	Modified California (non-standard)

Depth, (ft)	Sample No.	Blows / 6 in.	Other Tests	MATERIAL DESCRIPTION
0				Approximately 6 inches of asphalt pavement in three distinct layers (3-inch, 1.5-inch layer, thin layer of fabric, 1.5-inch).
	S-1	50/5.5		**FILL / DISTURBED NATIVE - Hf** Very dense, greyish-brown, silty fine SAND with abundant gravel: damp to moist, non-plastic fines, sub-angular gravel, disrupted soil structure. *-- Blowcounts may be overstated.*
2	S-2	14 32 43		**WEATHERED STEILACOOM GRAVEL - Qposg** Very dense, greyish-brown, slighty silty, sandy GRAVEL; damp, non-plastic fines, sub-angular fine and coarse gravel, uniform soil structure. *-- Abundant coarse gravel observed in soil cuttings returning to the surface. The soil captured within the sampler may not be representative of the soil unit due to the limited size of the opening. Blowcounts may be overstated.* *-- Gradual increase in gravel fraction with depth.*
4	S-3	50/5		**STEILACOOM GRAVEL - Qposg** Very dense, light grey, fine to coarse GRAVEL and COBBLES; damp, trace silt, some sand, non-plastic fines, sub-angular to sub-rounded gravel, and 3- to 9-inch sized subrounded cobbles.
6–8	S-4	50/5		*-- No recovery. Gradual decrease in sand and silt fractions with depth. Description based on visual observation of soil cuttings and drilling action.*
10	S-5	17 50/5		*-- Poor recovery. Small cobble stuck in the shoe of the sampler. Blowcounts may be overstated..*
12–14				Boring terminated approximately 10.9 feet below the road surface. Obvious signs of groundwater or groundwater seepage was not observed at the time of drilling.



Completion Depth:	10.9ft
Date Borehole Started:	2/12/20
Date Borehole Completed:	2/12/20
Logged By:	N. Weikel
Drilling Company:	Boretec 1, Inc.

Remarks: Modified California (MC) sampler driven with a 140 lb. safety hammer w/30" drop. Hammer operated with a rope and cathead mechanism. Coordinates and elevation are approximate and based on their relative location to known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: WGS84 / NAVD88**

PanGEO INCORPORATED

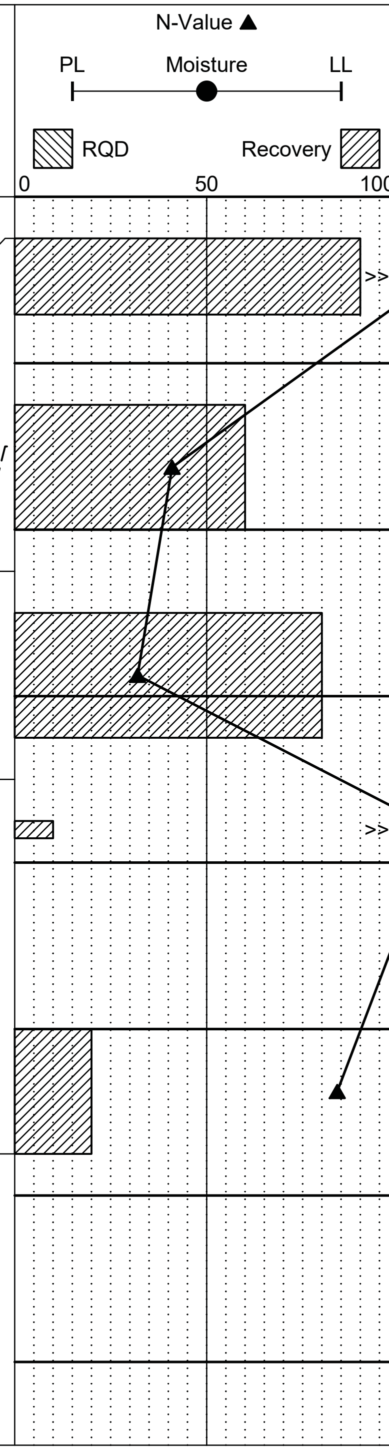
LOG OF TEST BORING PG-3

Figure A-4

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	JBLM North Access Improvement Project	Surface Elevation:	Approx. 262 feet
Job Number:	20-024	Top of Casing Elev.:	
Location:	Lakewood, WA	Drilling Method:	TD-85 trailer-mounted drill, hollow stem auger
Coordinates:	Northing: 47.14852, Easting: -122.546019	Sampling Method:	Modified California (non-standard)

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Approximately 5.5 inches of asphalt pavement in two distinct layers (2.5-inch, thin layer of fabric, 3-inch).
	S-1		40 50/5			**FILL / DISTURBED NATIVE - Hf** Very dense, greyish-brown, silty fine SAND with abundant gravel: damp to moist, non-plastic fines, sub-angular gravel, disrupted soil structure. *-- Blowcounts may be overstated.* *-- Abundant coarse gravel observed in soil cuttings returning to the surface. The soil captured within the sampler may not be representative of the soil unit due to the limited size of the opening. Blowcounts may be overstated.*
2	S-2		18 26 15			Medium dense to dense, medium brown, sandy GRAVEL with some silt; moist, non-plastic fines, disrupted soil structure.
4	S-33		14 17 15			**WEATHERED STEILACOOM GRAVEL - Qposg** Medium dense, greyish-brown, silty, sandy GRAVEL; moist, non-plastic fines, sub-angular fine and coarse gravel, uniform soil structure. *-- Gradual increase in gravel fraction and cobbles with depth.*
6	S-4		50/2.5			**STEILACOOM GRAVEL - Qposg** Very dense, light grey, fine to coarse GRAVEL and COBBLES; damp, trace silt, some sand, non-plastic fines, sub-angular to sub-rounded gravel, and 3- to 9-inch sized subrounded cobbles. *-- Gradual decrease in sand and silt fractions with depth.*
8						
10	S-5		8 48 36			*-- Limited recovery. Large fractured gravels observed in sampler. Blowcounts may be overstated.*
12						Boring terminated approximately 11.5 feet below the road surface. Obvious signs of groundwater or groundwater seepage was not observed at the time of drilling.
14						



Completion Depth:	11.5ft
Date Borehole Started:	2/12/20
Date Borehole Completed:	2/12/20
Logged By:	N. Weikel
Drilling Company:	Boretec 1, Inc.

Remarks: Modified California (MC) sampler driven with a 140 lb. safety hammer w/30" drop. Hammer operated with a rope and cathead mechanism. Coordinates and elevation are approximate and based on their relative location to known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: WGS84 / NAVD88**

PanGEO INCORPORATED

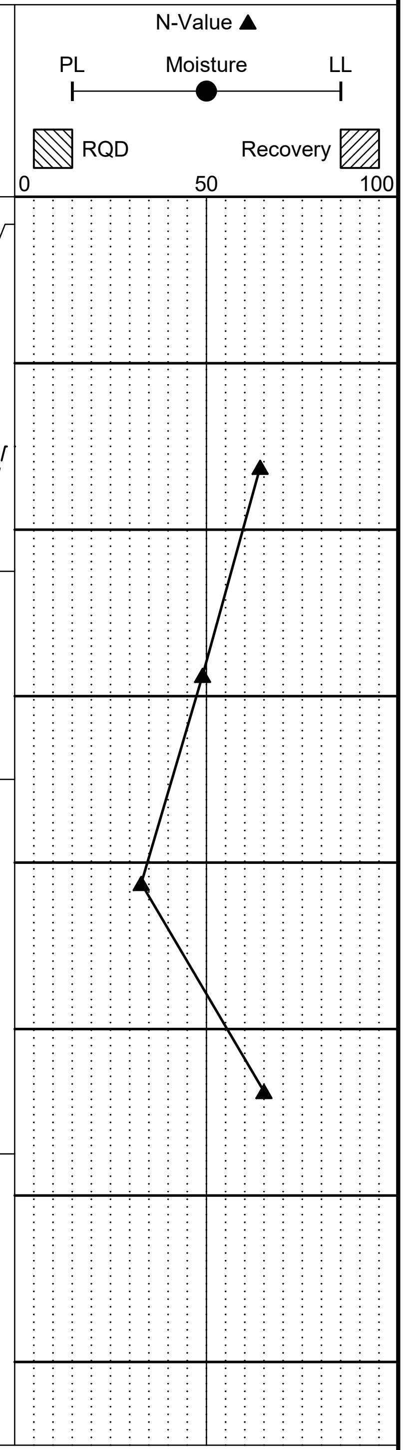
LOG OF TEST BORING PG-4

Figure A-5

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	JBLM North Access Improvement Project	Surface Elevation:	Approx. 262 feet
Job Number:	20-024	Top of Casing Elev.:	
Location:	Lakewood, WA	Drilling Method:	TD-85 trailer-mounted drill, hollow stem auger
Coordinates:	Northing: 47.148585, Easting: -122.54323	Sampling Method:	Modified California (non-standard)

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Approximately 4 inches of asphalt pavement in two distinct layers (2.5-inch, thin layer of fabric, 1.5-inch).
	S-1		35 50			**FILL / DISTURBED NATIVE - Hf** Very dense, greyish-brown, silty fine SAND with abundant gravel: moist, non-plastic fines, sub-angular fine gravel, disrupted soil structure. *-- Blowcounts may be overstated.* *-- Abundant coarse gravel observed in soil cuttings returning to the surface. The soil captured within the sampler may not be representative of the soil unit due to the limited size of the opening. Blowcounts may be overstated.*
2						
	S-2		11 34 30			Medium dense to dense, medium brown, sandy GRAVEL with some silt; moist, non-plastic fines, disrupted soil structure.
4						**WEATHERED STEILACOOM GRAVEL - Qposg** Dense, greyish-brown, silty, fine to coarse SAND with abundant gravel; moist, non-plastic fines, sub-angular to sub-rounded fine and coarse gravel, uniform soil structure.
6	S-3		16 27 22			*-- Gradual increase in moisture content with depth, becomes dark greyish-brown.*
						STEILACOOM GRAVEL - Qposg Very dense, light grey, silty SAND, with abundant gravel and scattered cobbles; moist, non-plastic fines, sub-angular to sub-rounded fine and coarse gravel, and 3- to 9-inch sized subrounded cobbles.
8	S-4		12 16 17			
10	S-5		12 15 50			*-- Same as above.*
12						Boring terminated approximately 11.5 feet below the road surface. Obvious signs of groundwater or groundwater seepage was not observed at the time of drilling.
14						



Completion Depth:	11.5ft
Date Borehole Started:	2/12/20
Date Borehole Completed:	2/12/20
Logged By:	N. Weikel
Drilling Company:	Boretec 1, Inc.

Remarks: Modified California (MC) sampler driven with a 140 lb. safety hammer w/30" drop. Hammer operated with a rope and cathead mechanism. Coordinates and elevation are approximate and based on their relative location to known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: WGS84 / NAVD88**

PanGEO INCORPORATED

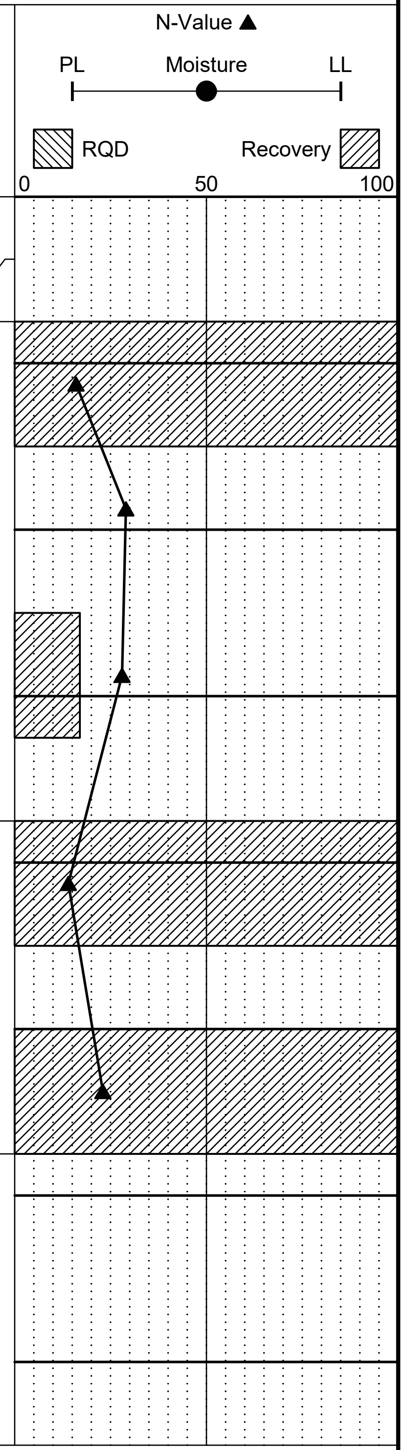
LOG OF TEST BORING PG-5

Figure A-6

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	JBLM North Access Improvement Project	Surface Elevation:	Approx. 260 feet
Job Number:	20-024	Top of Casing Elev.:	
Location:	Lakewood, WA	Drilling Method:	TD-85 trailer-mounted drill, hollow stem auger
Coordinates:	Northing: 47.14762, Easting: -122.53906	Sampling Method:	Modified California (non-standard)

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Approximately 9 inches of asphalt pavement overlay in four distinct layers (2-inch layer, 4.5-inch layer, 0.5-inch layer of gravel, 2-inch layer).
						Approximately 6 inches of concrete.
2	S-1		5, 7, 9			**FILL.** Medium dense, dark brown, silty fine SAND to fine sandy SILT, trace to some gravel (sub-angular, poorly graded); moist.
4	S-2		7, 14, 15			No recovery in sample S-2. Likely due to downhole gravel.
6	S-3		12, 14, 14			Medium dense, dark brown, silty fine sand to sandy SILT, trace to some gravel (sub-rounded, moderately to poorly graded); very moist.
8	S-4		10, 7, 7			**STEILACOOM GRAVEL - Qgosg.** Medium dense, brown, fine to medium sandy GRAVEL (sub-rounded, moderately to well graded), trace silt; moist; decrease in silt content with depth.
10	S-5		8, 9, 14			Slight increase in well graded sub-round gravel content in sample S-5.
12						Boring terminated approximately 11.5 feet below current road surface. Groundwater was not encountered at the time of drilling..
14						



Completion Depth:	11.5ft
Date Borehole Started:	2/13/20
Date Borehole Completed:	2/13/20
Logged By:	C. Venturino
Drilling Company:	Boretec 1, Inc.

Remarks: Modified California (MC) sampler driven with a 140 lb. safety hammer w/30" drop. Hammer operated with a rope and cathead mechanism. Coordinates and elevation are approximate and based on their relative location to known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: WGS84 / NAVD88**

PanGEO INCORPORATED

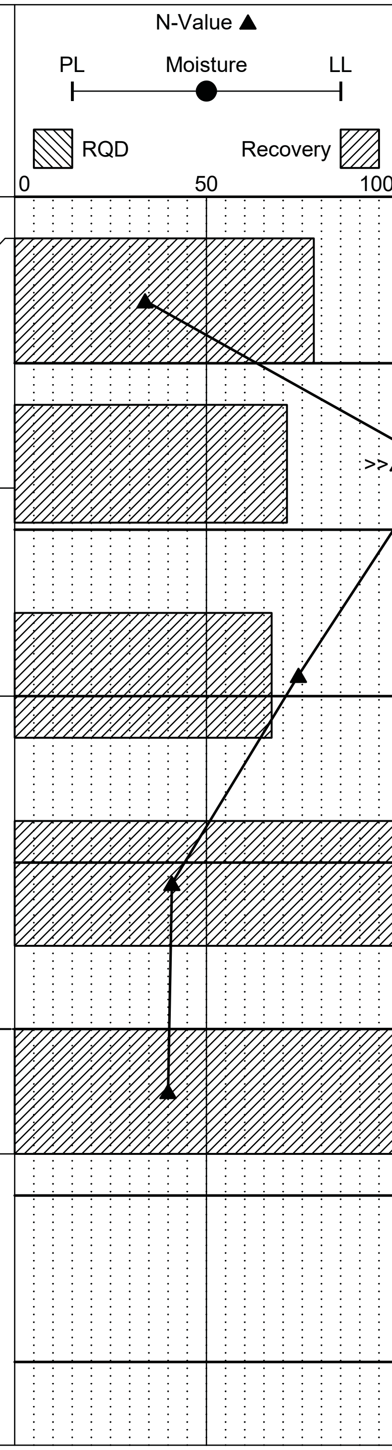
LOG OF TEST BORING PG-6

Figure A-7

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	JBLM North Access Improvement Project	Surface Elevation:	Approx. 270 feet
Job Number:	20-024	Top of Casing Elev.:	
Location:	Lakewood, WA	Drilling Method:	TD-85 trailer-mounted drill, hollow stem auger
Coordinates:	Northing: 47.142446, Easting: -122.536492	Sampling Method:	Modified California (non-standard)

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Approximately 5 inches of asphalt pavement overlay in two distinct layers (2-inch layer overlying a 3-inch layer).
	S-1		7, 12, 22			**FILL.** Dense, dark brown, silty fine SAND, trace gravel (sub-angular, poor to moderately graded), trace non-organic debris (brick fragment); moist; slight increase in moisture with depth.
2	S-2		7, 25, 50/5			Increase in sand and gravel in lower 4 inches of sample. Hammer observed bouncing during SPT. Downhole gravel may have inflated the blow counts.
4	S-3		29, 24, 50			**WEATHERED STEILACOOM GRAVEL - Qposg.** Very dense, light brown to dark brown, fine to medium SAND, trace to some gravel (sub-rounded, well-graded), trace silt; moist.
6	S-4		18, 18, 23			**STEILACOOM GRAVEL - Qposg.** Dense, light brown, fine to medium sandy GRAVEL (sub-angular to sub-rounded, well graded), trace silt; moist; slight decrease in sand content with depth.
8						
10	S-5		35, 23, 17			Dense, brown to orange, fine to medium sandy GRAVEL (sub-rounded, moderately to well graded) to gravelly fine to medium SAND, trace to some silt, trace iron oxide staining; moist.
12						Boring terminated approximately 11.5 feet below current road surface. Groundwater was not encountered at the time of drilling.
14						



Completion Depth:	11.5ft
Date Borehole Started:	2/13/20
Date Borehole Completed:	2/13/20
Logged By:	C. Venturino
Drilling Company:	Boretec 1, Inc.

Remarks: Modified California (MC) sampler driven with a 140 lb. safety hammer w/30" drop. Hammer operated with a rope and cathead mechanism. Coordinates and elevation are approximate and based on their relative location to known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: WGS84 / NAVD88**

PanGEO INCORPORATED

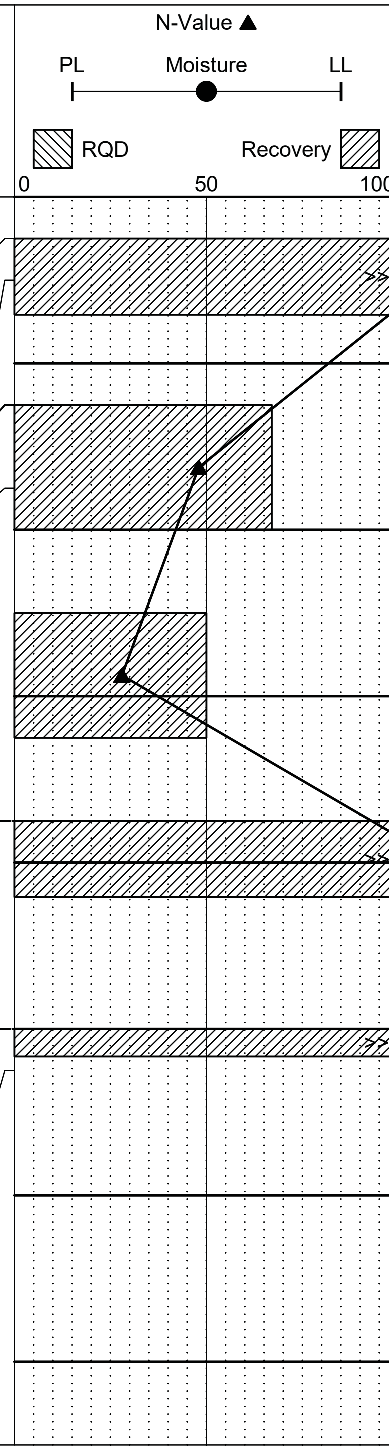
LOG OF TEST BORING PG-7

Figure A-8

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	JBLM North Access Improvement Project	Surface Elevation:	Approx. 279 feet
Job Number:	20-024	Top of Casing Elev.:	
Location:	Lakewood, WA	Drilling Method:	TD-85 trailer-mounted drill, hollow stem auger
Coordinates:	Northing: 47.14114, Easting: -122.528968	Sampling Method:	Modified California (non-standard)

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Approximately 5.5 inches of asphalt pavement overlay in two distinct layers (2-inch layer overlying a 3-inch layer).
	S-1		23, 50/5			**FILL.** Approximately 5 inches of sub-angular, well graded, base course gravel fill.
2						Very dense, brown to gray, silty fine to medium SAND, trace to some gravel (sub-angular, well graded); moist to very moist; fractured gravel in cap tip may have inflated the blow count.
	S-2		21, 23, 25			Dense, brown to gray, fine to medium sandy GRAVEL (sub-angular to sub-rounded, well graded to poorly graded), trace to some silt; moist; upper 6 inches of sample sub-angular, well graded gravel fill.
4						**STEILACOOM GRAVEL - Qposg.**
6	S-3		11, 12, 16			Medium dense, brown, fine to medium sandy GRAVEL (sub-rounded, poorly graded), trace silt; moist to very moist; slight increase in sand content with depth.
8	S-4		15, 50/5			Very dense, brown, silty fine to medium SAND with gravel (sub-rounded, poorly graded); moist; hammer observed bouncing during SPT. Downhole gravel may have inflated the blow count.
10	S-5		50/4			Very dense, brown, fine to medium sandy GRAVEL (sub-rounded, poorly graded), trace silt; moist; hammer observed bouncing during SPT. Downhole gravel may have inflated the blow count.
						Boring terminated approximately 10.5 feet below current road surface. Groundwater was not encountered at the time of drilling.
12						
14						



Completion Depth:	10.5ft
Date Borehole Started:	2/13/20
Date Borehole Completed:	2/13/20
Logged By:	C. Venturino
Drilling Company:	Boretec 1, Inc.

Remarks: Modified California (MC) sampler driven with a 140 lb. safety hammer w/30" drop. Hammer operated with a rope and cathead mechanism. Coordinates and elevation are approximate and based on their relative location to known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: WGS84 / NAVD88**

PanGEO INCORPORATED

LOG OF TEST BORING PG-8

Figure A-9

The stratification lines represent approximate boundaries. The transition may be gradual.

APPENDIX B

SUMMARY TEST PIT LOGS

Test Pit PIT-1
Location: 47.14863, -122.56243 (See Figure 2)
Approximate ground surface elevation: 238 feet (Based on Google Earth)

Depth (ft)	Material Description
0 – ¼	Medium dense, grey, fine gravelly coarse SAND; moist; poorly graded, angular gravel, crushed rock **(Fill)**
¼ – ½	Loose, brown, silty fine SAND; moist; poorly graded **(Fill)**
½ – 2	Loose, dark brown, slightly organic, sandy, gravelly SILT; moist; poorly graded, non-plastic **(Old Topsoil/Fill)** • Grades to sandy gravel
2 – 6	Loose, grey-brown, slightly sandy to sandy GRAVEL; moist; poorly graded **(Steilacoom Gravel)**

Test Pit 1 (PIT-1) was initially terminated approximately 4 feet below grade for infiltration testing. After the test, PIT-1 was over excavated to check for high groundwater or immediate groundwater mounding.

No groundwater seepage or mounding was observed during the excavations. PIT-1 terminated approximately 6 feet below ground surface in caving conditions.

Figure B-1

Test Pit PIT-2 Location: 47.145818, -122.560086 (See Figure 2) Approximate ground surface elevation: 261 feet (Based on Google Earth)	
Depth (ft)	Material Description
0 – ½	Grass and sod over loose, brown to dark brown, silty fine to medium SAND, trace gravel, trace organic material (rootlets); moist; **(Fill)**
½ – 1½	Loose, light brown, fine to medium SAND with gravel, trace silt, trace organic debris (rootlets); moist; **(Steilacoom Gravel)**
1½ - 6	Loose to medium dense, light brown to brown, fine to medium SAND, trace silt; moist; lens of fine sand between approx. 2 and 2½ feet.

Test Pit 2 (PIT-2) was initially terminated approximately 4 feet below grade for infiltration testing. After the test, PIT-2 was over excavated to check for high groundwater or immediate groundwater mounding.

No groundwater seepage or mounding was observed during the excavations. PIT-2 terminated approximately 6 feet below ground surface in caving conditions.

Figure B-2

Test Pit PIT-3 Location: 47.148650, -122.551497 (See Figure 2) Approximate ground surface elevation: 260 feet (Based on Google Earth)	
Depth (ft)	Material Description
0 – 1½	Grass and sod over loose, dark brown, silty fine to medium SAND, trace gravel, trace organic material (rootlets); moist; **(Fill)**
1½ – 7	Loose to medium dense, brown, fine to medium sandy GRAVEL (sub-rounded, poorly graded) to gravelly fine to medium SAND; moist; unit becomes less weathered with depth **(Steilacoom Gravel)**

Test Pit 3 (PIT-3) was initially terminated approximately 4 feet below grade for infiltration testing. After the test, PIT-3 was over excavated to check for high groundwater or immediate groundwater mounding.

No groundwater seepage or mounding was observed during the excavations. PIT-3 terminated approximately 7 feet below ground surface in caving conditions.

Figure B-3

Test Pit PIT-4 Location: 47.14867, -122.54450 (See Figure 2) Approximate ground surface elevation: 262 feet (Based on Google Earth)	
Depth (ft)	Material Description
0 – 2	Grass and sod over loose, dark brown, slightly organic, slightly silty, sandy GRAVEL; moist; poorly graded, rootlets **(Fill)**
2 – 7	Loose, grey-brown, slightly sandy GRAVEL; moist; poorly graded **(Steilacoom Gravel)**

Test Pit 4 (PIT-4) was initially terminated approximately 4 feet below grade for infiltration testing. After the test, PIT-4 was over excavated to check for high groundwater or immediate groundwater mounding.

No groundwater seepage or mounding was observed during the excavations. PIT-4 terminated approximately 7 feet below ground surface in caving conditions.

Figure B-4

Test Pit PIT-5
Location: 47.14335, -122.53765 (See Figure 2)
Approximate ground surface elevation: 275 feet (Based on Google Earth)

Depth (ft)	Material Description
0 – ¼	Medium dense, grey, fine gravelly coarse SAND; moist; poorly graded, angular gravel, crushed rock **(Fill)**
¼ – 2¼	Grass and sod over loose, dark brown, slightly organic, slightly silty, sandy GRAVEL; moist; poorly graded, rootlets **(Fill)**
2¼ – 6	Loose, grey-brown, slightly sandy GRAVEL; moist; poorly graded **(Steilacoom Gravel)**

Test Pit 5 (PIT-5) was initially terminated approximately 4 feet below grade for infiltration testing. After the test, PIT-5 was over excavated to check for high groundwater or immediate groundwater mounding.

No groundwater seepage or mounding was observed during the excavations. PIT-5 terminated approximately 6 feet below ground surface in caving conditions.

Test Pit PIT-6 Location: 47.141247, -122.526488 (See Figure 2) Approximate ground surface elevation: 278 feet (Based on Google Earth)	
Depth (ft)	Material Description
0 – 1	Grass and sod over loose, dark brown, silty fine to medium SAND, trace gravel, trace organic material (rootlets); moist; **(Fill)**
1 – 2	Loose, brown to orange, fine to medium SAND with gravel, trace silt; moist; appears to be reworked native material
2 – 4	Loose, dark brown, silty fine to medium SAND, trace to some gravel, trace organic material (rootlets); moist.**(Old Topsoil/Fill)**
4 – 6¾	Loose to medium dense, light brown to brown, fine to medium sandy GRAVEL (sub-rounded, poorly graded), trace silt; moist; becomes less weathered with depth **(Steilacoom Gravel)**

Test Pit 6 (PIT-6) was initially terminated approximately 4 feet below grade for infiltration testing. After the test, PIT-6 was over excavated to check for high groundwater or immediate groundwater mounding.

No groundwater seepage or mounding was observed during the excavations. PIT-6 terminated approximately 6¾ feet below ground surface in caving conditions.

Test Pits Excavated: February 11 (PIT-3 and PIT-4), 12 (PIT-5 and PIT-6), and 13 (PIT-1 and PIT-2), 2020 using a rubber-tread backhoe operated by Swope Excavating.

Test Pits Logged by: Christian Venturino and Bart Weitering on February 11, 12, and 13, 2020.

APPENDIX C

PREVIOUS BORING LOG

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LESS THAN 5% FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (GREATER THAN 12% FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LESS THAN 5% FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50 OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (GREATER THAN 12% FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	INORGANIC		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	LIQUID LIMIT LESS THAN 50	ORGANIC		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	INORGANIC		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
	LIQUID LIMIT GREATER THAN 50	ORGANIC		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS
FILL SOILS				FILL (AF)	HUMAN ALTERED SOIL OR MODIFIED LAND

NOTES:

1. SOIL DESCRIPTIONS ARE BASED ON THE GENERAL APPROACH PRESENTED IN THE STANDARD PRACTICE FOR DESCRIPTION AND IDENTIFICATION OF SOILS (VISUAL-MANUAL PROCEDURE), AS OUTLINED IN ASTM D 2488. WHERE LABORATORY INDEX TESTING HAS BEEN CONDUCTED, SOIL CLASSIFICATIONS ARE BASED ON THE STANDARD TEST METHOD FOR CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES, AS OUTLINED IN ASTM D 2487.
2. SOIL DESCRIPTION TERMINOLOGY IS BASED ON VISUAL ESTIMATES (IN THE ABSENCE OF LABORATORY TEST DATA) OF THE PERCENTAGES OF EACH SOIL TYPE AND IS DEFINED AS DESCRIBED BELOW:
3. DUAL SYMBOLS (E.G. SP-SM, OR GP-GM) ARE USED TO INDICATE A SOIL WITH AN ESTIMATED 5-12% FINES.

PRIMARY CONSTITUENT: >50% - "GRAVEL", "SAND", "SILT", "CLAY", etc.
SECONDARY CONSTITUENTS: >12% and ≤50% - "gravelly", "sandy", "silty", etc.
ADDITIONAL CONSTITUENTS: >5% and ≤12% - "some gravel", "some sand", "some silt", etc.
≤5% - "trace gravel", "trace sand", "trace silt" etc. or not noted.

4. RELATIVE DENSITY OF SOIL IS BASED ON STANDARD TEST METHOD FOR PENETRATION TEST (SPT) AND SPLIT-BARREL SAMPLING OF SOILS ASTM D 1586 OR CORRELATIONS FOR OTHER SIMPLER TYPES AND METHODS FOR SPT SAMPLING, THE FOLLOWING BLOW COUNT CORRELATION APPLIES.

A. RELATIVE DENSITY OF COARSE GRAINED SOILS (N = BLOWS/FOOT SPT METHOD)
- VERY LOOSE: N = ≤4
- LOOSE: N = >4 AND ≤10
- MEDIUM DENSE: N = >10 AND ≤30
- DENSE: N = >30 AND ≤50
- VERY DENSE: N = >50

B. RELATIVE CONSISTENCY OF FINE GRAINED SOILS (N = BLOWS/FOOT SPT METHOD)
- VERY SOFT: N = <2
- SOFT: N = ≥2 AND ≤4
- MEDIUM STIFF: N = >4 AND ≤8
- STIFF: N = >8 AND ≤15
- VERY STIFF: N = >15 AND ≤30
- HARD: N = >30

DRAWN BY: JRS CHECKED BY: JD

Wood Environment & Infrastructure Solutions, Inc.
221 S 28th Street, Suite 102
Tacoma, WA 98402

wood.

SOIL CLASSIFICATION CHART / KEY

DATE: NOVEMBER 2019
SCALE: NOT TO SCALE
PROJECT NO.:
FIGURE: C-1

PROJECT: Veterans DR SW, Lakewood, Washington **JOB No. PS19202580** **BORING No. B-8**

Location: Middle of Northbound Lane (Gravelly Lake DR SW)

Approximate ground surface elevation: 267 feet

DEPTH (feet)	Soil Description	USCS/USGS GRAPHICS	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER	PENETRATION RESISTANCE (Standard ▲ / Other △, Blows per foot; 0–50)	TESTING
0	Asphalt Pavement (6-1/2-inches)						
	Medium dense, moist, grey to brown, sandy GRAVEL with some silt; (Fill) GW-GM		27%	S-1A	N/E		
	Medium dense, moist, grey to brown, Well-graded sandy GRAVEL with trace of silt; (Steilacoom Gravel) GW		100%	S-1B		25	Grain Size 3; Organic Content 5
			60%	S-2		17	
	Medium dense, moist, brown, Poorly-graded sandy GRAVEL with trace of silt; (Steilacoom Gravel) GP						
5			20%	S-3		17	Grain Size 2; Organic Content 2
	Boring terminated at approximately 6.5 feet						
10							

MOISTURE CONTENT: 0 20 40 60 80 100 — Plastic Limit / Liquid Limit

LEGEND

- 2.00-inch OD split-spoon sampler
- N/E No groundwater encountered
- Grain Size Analysis (% fines shown)
- Organic Content (% shown)

wood.

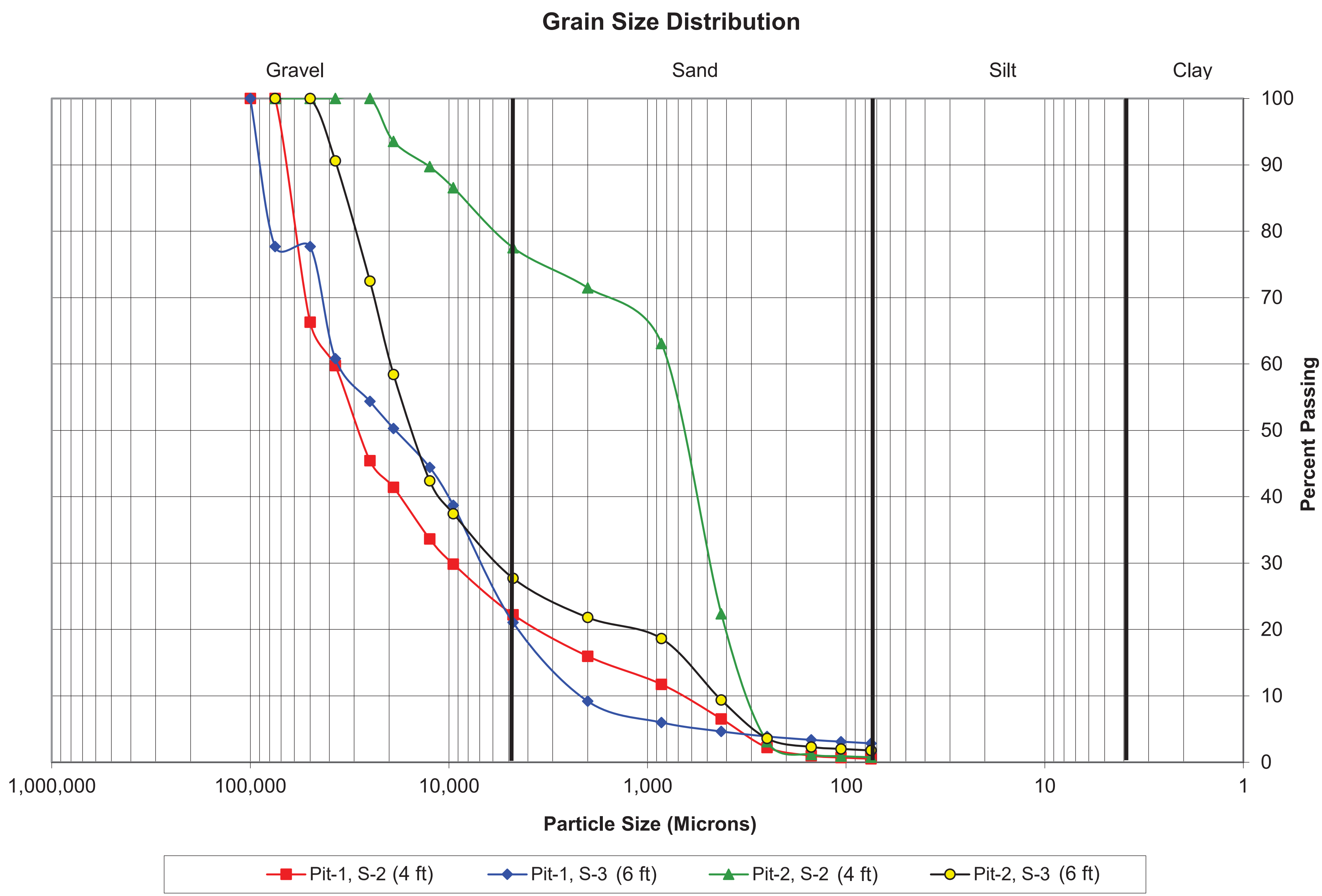
221 S 28th Street, Suite 102
Tacoma, WA 98402

Drilled by: *Geologic Drill* Hammer Type: Cathead Date drilled: *June 12, 2019* Logged By: *CM*

Drilling Method: HSA

APPENDIX D

GEOTECHNICAL LABORATORY TEST RESULTS



Grain Size Distribution
Gravel
Sand
Silt
Clay
Percent Passing
100
90
80
70
60
50
40
30
20
10
0
1,000,000
100,000
10,000
1,000
100
10
1
Particle Size (Microns)
Pit-1, S-2 (4 ft)
Pit-1, S-3 (6 ft)
Pit-2, S-2 (4 ft)
Pit-2, S-3 (6 ft)

Figure D-1

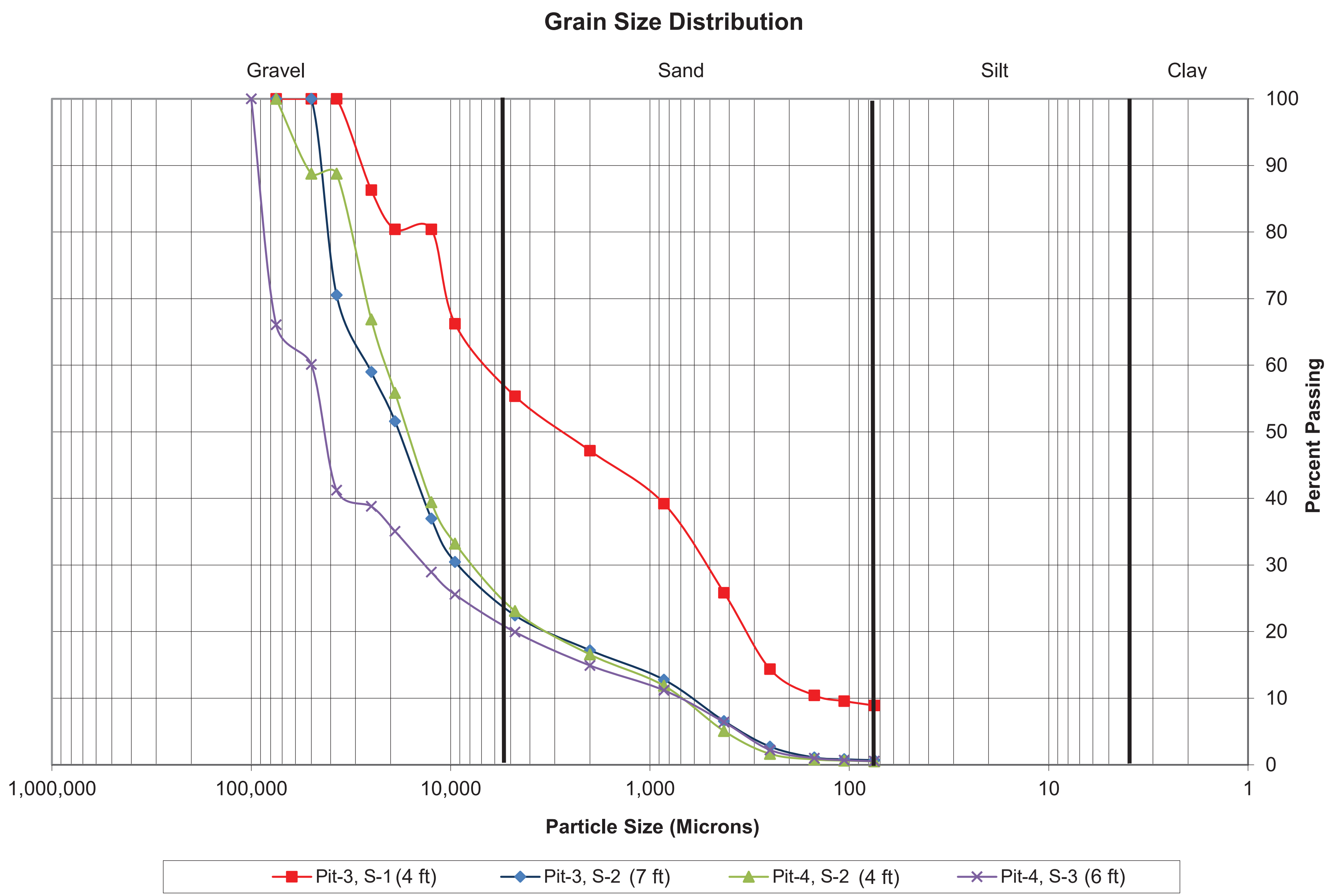
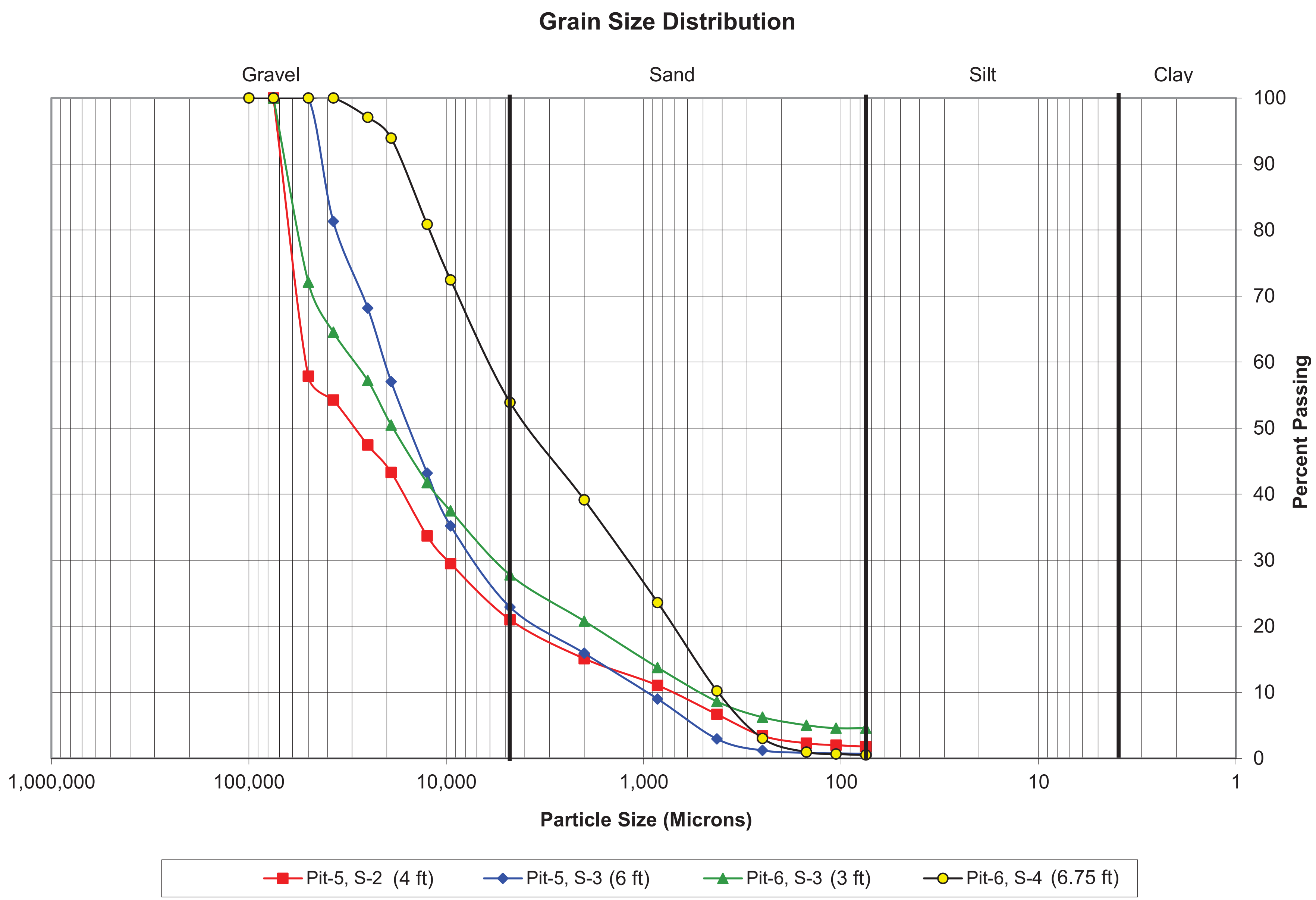

Grain Size Distribution
Gravel
Sand
Silt
Clay
100
90
80
70
60
50
40
30
20
10
0
Percent Passing
1,000,000
100,000
10,000
1,000
100
10
1
Particle Size (Microns)
Pit-3, S-1 (4 ft)
Pit-3, S-2 (7 ft)
Pit-4, S-2 (4 ft)
Pit-4, S-3 (6 ft)

Figure D-2



Grain Size Distribution
Gravel
Sand
Silt
Clay
100
90
80
70
60
50
40
30
20
10
0
Percent Passing
1,000,000
100,000
10,000
1,000
100
10
1
Particle Size (Microns)
Pit-5, S-2 (4 ft)
Pit-5, S-3 (6 ft)
Pit-6, S-3 (3 ft)
Pit-6, S-4 (6.75 ft)

Figure D-3

APPENDIX E

ANALYTICAL LABORATORY TEST RESULTS

3600 Fremont Ave. N.
Seattle, WA 98103
T: (206) 352-3790
F: (206) 352-7178
info@fremontanalytical.com

PanGEO Inc.
Scott Dinkelman
3213 Easklake Ave E. Suite B
Seattle, WA 98102

RE: Lakewood Pavement Restoration
Work Order Number: 2002285

February 20, 2020

Attention Scott Dinkelman:

Fremont Analytical, Inc. received 9 sample(s) on 2/17/2020 for the analyses presented in the following report.

Cation Exchange Capacity by EPA 9081
Organic Matter of Organic Soils by ASTM D2974

This report consists of the following:

- Case Narrative
- Analytical Results
- Applicable Quality Control Summary Reports
- Chain of Custody

All analyses were performed consistent with the Quality Assurance program of Fremont Analytical, Inc. Please contact the laboratory if you should have any questions about the results.

Thank you for using Fremont Analytical.

Sincerely,

Brianna Barnes
Project Manager

CLIENT: PanGEO Inc.
Project: Lakewood Pavement Restoration
Work Order: 2002285

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Date/Time Collected	Date/Time Received
2002285-001	PIT-1 S-2	02/13/2020 9:00 AM	02/17/2020 1:22 PM
2002285-002	PIT-2 S-2	02/13/2020 9:00 AM	02/17/2020 1:22 PM
2002285-003	PIT-3 S-1	02/11/2020 9:00 AM	02/17/2020 1:22 PM
2002285-004	PIT-4 S-2	02/11/2020 9:00 AM	02/17/2020 1:22 PM
2002285-005	PIT-5 S-2	02/12/2020 9:00 AM	02/17/2020 1:22 PM
2002285-006	PIT-6 S-2	02/12/2020 9:00 AM	02/17/2020 1:22 PM
2002285-007	PIT-1 S-2	02/13/2020 9:00 AM	02/17/2020 1:22 PM
2002285-008	PIT-4 S-2	02/11/2020 9:00 AM	02/17/2020 1:22 PM
2002285-009	PIT-6 S-2	02/12/2020 9:00 AM	02/17/2020 1:22 PM

Figure C-8

CLIENT: PanGEO Inc.

Project: Lakewood Pavement Restoration

I. SAMPLE RECEIPT:

Samples receipt information is recorded on the attached Sample Receipt Checklist.

II. GENERAL REPORTING COMMENTS:

Results are reported on a wet weight basis unless dry-weight correction is denoted in the units field on the analytical report ("mg/kg-dry" or "ug/kg-dry").

Matrix Spike (MS) and MS Duplicate (MSD) samples are tested from an analytical batch of "like" matrix to check for possible matrix effect. The MS and MSD will provide site specific matrix data only for those samples which are spiked by the laboratory. The sample chosen for spike purposes may or may not have been a sample submitted in this sample delivery group. The validity of the analytical procedures for which data is reported in this analytical report is determined by the Laboratory Control Sample (LCS) and the Method Blank (MB). The LCS and the MB are processed with the samples and the MS/MSD to ensure method criteria are achieved throughout the entire analytical process.

III. ANALYSES AND EXCEPTIONS:

Exceptions associated with this report will be footnoted in the analytical results page(s) or the quality control summary page(s) and/or noted below.

Figure C-9

Qualifiers:

* - Flagged value is not within established control limits
B - Analyte detected in the associated Method Blank
D - Dilution was required
E - Value above quantitation range
H - Holding times for preparation or analysis exceeded
I - Analyte with an internal standard that does not meet established acceptance criteria
J - Analyte detected below Reporting Limit
N - Tentatively Identified Compound (TIC)
Q - Analyte with an initial or continuing calibration that does not meet established acceptance criteria (<20%RSD, <20% Drift or minimum RRF)
S - Spike recovery outside accepted recovery limits
ND - Not detected at the Reporting Limit
R - High relative percent difference observed

Acronyms:

%Rec - Percent Recovery
CCB - Continued Calibration Blank
CCV - Continued Calibration Verification
DF - Dilution Factor
HEM - Hexane Extractable Material
ICV - Initial Calibration Verification
LCS/LCSD - Laboratory Control Sample / Laboratory Control Sample Duplicate
MB or MBLANK - Method Blank
MDL - Method Detection Limit
MS/MSD - Matrix Spike / Matrix Spike Duplicate
PDS - Post Digestion Spike
Ref Val - Reference Value
RL - Reporting Limit
RPD - Relative Percent Difference
SD - Serial Dilution
SGT - Silica Gel Treatment
SPK - Spike
Surr - Surrogate

Analytical Report

Work Order: **2002285**
Date Reported: **2/20/2020**

CLIENT: PanGEO Inc.
Project: Lakewood Pavement Restoration

Lab ID: 2002285-001 **Collection Date:** 2/13/2020 9:00:00 AM
Client Sample ID: **PIT-1 S-2** **Matrix:** Soil

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Cation Exchange Capacity by EPA 9081				Batch ID: R57507		Analyst: CO
Cation Exchange Capacity	5.58	1.00		meq/100g	1	2/20/2020 3:04:51 PM

Lab ID: 2002285-002 **Collection Date:** 2/13/2020 9:00:00 AM
Client Sample ID: **PIT-2 S-2** **Matrix:** Soil

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Cation Exchange Capacity by EPA 9081				Batch ID: R57507		Analyst: CO
Cation Exchange Capacity	4.79	1.00		meq/100g	1	2/20/2020 3:15:57 PM

Lab ID: 2002285-003 **Collection Date:** 2/11/2020 9:00:00 AM
Client Sample ID: **PIT-3 S-1** **Matrix:** Soil

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Cation Exchange Capacity by EPA 9081				Batch ID: R57507		Analyst: CO
Cation Exchange Capacity	19.8	1.00		meq/100g	1	2/20/2020 3:21:30 PM

Lab ID: 2002285-004 **Collection Date:** 2/11/2020 9:00:00 AM
Client Sample ID: **PIT-4 S-2** **Matrix:** Soil

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Cation Exchange Capacity by EPA 9081				Batch ID: R57507		Analyst: CO
Cation Exchange Capacity	5.07	1.00		meq/100g	1	2/20/2020 3:27:04 PM

Figure C-11

Fremont Analytical

Analytical Report

Work Order: **2002285**
Date Reported: **2/20/2020**

CLIENT: PanGEO Inc.
Project: Lakewood Pavement Restoration

Lab ID: 2002285-005 **Collection Date:** 2/12/2020 9:00:00 AM
Client Sample ID: **PIT-5 S-2** **Matrix:** Soil

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Cation Exchange Capacity by EPA 9081				Batch ID: R57507		Analyst: CO
Cation Exchange Capacity	9.09	1.00		meq/100g	1	2/20/2020 3:32:37 PM

Lab ID: 2002285-006 **Collection Date:** 2/12/2020 9:00:00 AM
Client Sample ID: **PIT-6 S-2** **Matrix:** Soil

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Cation Exchange Capacity by EPA 9081				Batch ID: R57507		Analyst: CO
Cation Exchange Capacity	19.7	1.00		meq/100g	1	2/20/2020 3:38:10 PM

Lab ID: 2002285-007 **Collection Date:** 2/13/2020 9:00:00 AM
Client Sample ID: **PIT-1 S-2** **Matrix:** Soil

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Organic Matter of Organic Soils by ASTM D2974				Batch ID: R57488		Analyst: SS
Organic Matter	2.31	0.500		%	1	2/18/2020 10:00:00 AM

Lab ID: 2002285-008 **Collection Date:** 2/11/2020 9:00:00 AM
Client Sample ID: **PIT-4 S-2** **Matrix:** Soil

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Organic Matter of Organic Soils by ASTM D2974				Batch ID: R57488		Analyst: SS
Organic Matter	1.96	0.500		%	1	2/18/2020 10:00:00 AM

Figure C-12

Analytical Report

Work Order: **2002285**
Date Reported: **2/20/2020**

CLIENT: PanGEO Inc.
Project: Lakewood Pavement Restoration

Lab ID: 2002285-009 **Collection Date:** 2/12/2020 9:00:00 AM
Client Sample ID: **PIT-6 S-2** **Matrix:** Soil

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Organic Matter of Organic Soils by ASTM D2974				Batch ID: R57488		Analyst: SS
Organic Matter	2.02	0.500		%	1	2/18/2020 10:00:00 AM

Figure C-13

Fremont Analytical

Date: *2/20/2020*

Work Order: 2002285
CLIENT: PanGEO Inc.
Project: Lakewood Pavement Restoration

QC SUMMARY REPORT

Cation Exchange Capacity by EPA 9081

Sample ID: **MB-R57507** SampType: **MBLK** Units: **meq/100g** Prep Date: **2/20/2020** RunNo: **57507**
Client ID: **MBLKS** Batch ID: **R57507** Analysis Date: **2/20/2020** SeqNo: **1147566**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cation Exchange Capacity	ND	1.00									

Sample ID: **LCS-R57507** SampType: **LCS** Units: **µg/L** Prep Date: **2/20/2020** RunNo: **57507**
Client ID: **LCSS** Batch ID: **R57507** Analysis Date: **2/20/2020** SeqNo: **1147567**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Sodium	942	100	1,000	0	94.2	75	125				

Sample ID: **2002285-001ADUP** SampType: **DUP** Units: **meq/100g** Prep Date: **2/20/2020** RunNo: **57507**
Client ID: **PIT-1 S-2** Batch ID: **R57507** Analysis Date: **2/20/2020** SeqNo: **1147569**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cation Exchange Capacity	5.28	1.00						5.578	5.50	30	

Figure C-14

Fremont Analytical

Sample Log-In Check List

Client Name:	**PANGEO**	Work Order Number:	**2002285**
Logged by:	**Carissa True**	Date Received:	**2/17/2020 1:22:00 PM**

Chain of Custody

1.	Is Chain of Custody complete?	Yes ☑	No ☐	Not Present ☐
2.	How was the sample delivered?	Client		

Log In

3.	Coolers are present?	Yes ☐	No ☑	NA ☐
		No cooler present		
4.	Shipping container/cooler in good condition?	Yes ☑	No ☐	
5.	Custody Seals present on shipping container/cooler? (Refer to comments for Custody Seals not intact)	Yes ☐	No ☐	Not Required ☑
6.	Was an attempt made to cool the samples?	Yes ☐	No ☑	NA ☐
		Unknown prior to receipt		
7.	Were all items received at a temperature of >2°C to 6°C *	Yes ☐	No ☑	NA ☐
		Please refer to item information		
8.	Sample(s) in proper container(s)?	Yes ☑	No ☐	
9.	Sufficient sample volume for indicated test(s)?	Yes ☑	No ☐	
10.	Are samples properly preserved?	Yes ☑	No ☐	
11.	Was preservative added to bottles?	Yes ☐	No ☑	NA ☐
12.	Is there headspace in the VOA vials?	Yes ☐	No ☐	NA ☑
13.	Did all samples containers arrive in good condition(unbroken)?	Yes ☑	No ☐	
14.	Does paperwork match bottle labels?	Yes ☑	No ☐	
15.	Are matrices correctly identified on Chain of Custody?	Yes ☑	No ☐	
16.	Is it clear what analyses were requested?	Yes ☑	No ☐	
17.	Were all holding times able to be met?	Yes ☑	No ☐	

Special Handling (if applicable)

18.	Was client notified of all discrepancies with this order?	Yes ☑	No ☐	NA ☐

Person Notified:	Christian Venturino	Date:	2/17/2020
By Whom:	Carissa True	Via:	☑ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:	Earliest TAT possible is 3 Day not 2 Day		
Client Instructions:	Okay with client		

19. Additional remarks:

Item Information

Item #	Temp °C
Sample 1	20.8

* Note: DoD/ELAP and TNI require items to be received at 4°C +/- 2°C

Figure C-15

Fremont Analytical
3600 Fremont Ave N.
Seattle, WA 98103
Tel: 206-352-3790
Fax: 206-352-7178

Chain of Custody Record & Laboratory Services Agreement

Date: 2/17/20 Page: 1 of: 1
Laboratory Project No (internal): 2002285

Client: Pan GEO, inc
Address: 3213 Eastlake Ave E, suite B
City, State, Zip: Seattle, WA 98055
Telephone: 206-262-0370
Fax:

Project Name: Lakewood Pavement Restoration
Project No: 20-024
Collected by:
Location:
Report To (PM): Scott ~~Dinkleman~~ Dinkleman
PM Email: Sdinkleman@Pangeoinc.com

Special Remarks:

Sample Disposal: ☐ Return to client ☒ Disposal by lab (after 30 days)

#	Sample Name	Sample Date	Sample Time	Sample Type (Matrix)*	VOCs (EPA 8260 / 624)	GX/BTEX	BTEX	Gasoline Range Organics (GX)	Hydrocarbon Identification (HCID)	Diesel/Heavy Oil Range Organics (DX)	SVOCs (EPA 8270 / 625)	PAHs (EPA 8270 - SIM)	PCBs (EPA 8082 / 608)	Metals** (EPA 6020 / 200.8)	Total (T) / Dissolved (D)	Anions (IC)***	EDB (8011)	Cation Exchange	Organic Content	Comments
1	PIT-1 S-2	2/13/20	9 AM															X		
2	PIT-2 S-2	2/13/20																X		
3	PIT-3 S-1	2/11/20																X		
4	PIT-4 S-2	2/11/20																X		
5	PIT-5 S-2	2/12/20																X		
6	PIT-6 S-2	2/12/20																X		
7	PIT-1 S-2	2/13/20																	X	
8	PIT-4 S-2	2/11/20																	X	
9	PIT-6 S-2	2/12/20																	X	
10																				

*Matrix: A = Air, AQ = Aqueous, B = Bulk, O = Other, P = Product, S = Soil, SD = Sediment, SL = Solid, W = Water, DW = Drinking Water, GW = Ground Water, SW = Storm Water, WW = Waste Water

**Metals (Circle): MTCA-5 RCRA-8 Priority Pollutants TAL *Individual:* Ag Al As B Ba Be Ca Cd Co Cr Cu Fe Hg K Mg Mn Mo Na Ni Pb Sb Se Sr Sn Ti Tl U V Zn

***Anions (Circle): Nitrate Nitrite Chloride Sulfate Bromide O-Phosphate Fluoride Nitrate+Nitrite

I represent that I am authorized to enter into this Agreement with Fremont Analytical on behalf of the Client named above and that I have verified Client's agreement to each of the terms on the front and backside of this Agreement.

Relinquished	Date/Time	Received	Date/Time
x Christian Venturino	2/17/20 1:20 pm	x	
x [signature]	" "	x [signature]	2/17/20 1322

Turn-around Time:
☐ Standard
☐ 3 Day
☒ 2 Day ASAP
☐ Next Day
Same Day ______ (specify)

www.fremontanalytical.com

Figure C-16

APPENDIX F

PHOTOS OF PAVEMENT CORES

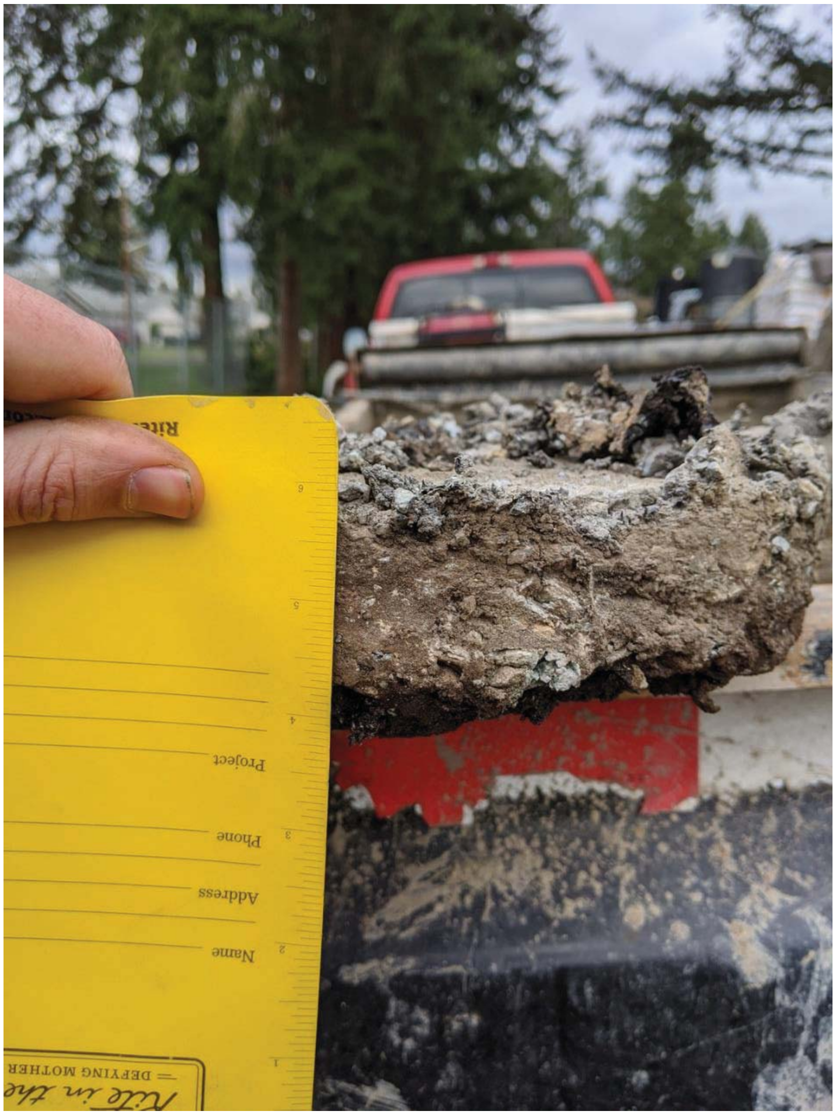
<table>
<tr><th colspan="2">PG-1</th></tr>
<tr><td>Location: 47.14651, -122.565765 (Approximately 9616 Northgate Rd SW)
Subgrade Condition: Dense, silty fine to coarse sand with gravel</td><td>Pavement Thickness</td></tr>
<tr><td>

Photo of partial asphalt core at PG-1 location. No obvious signs of layering.</td><td>4 inches</td></tr>
<tr><td>Notes:
1. Boring PG-1 cored/drilled in westbound lane of Northgate Road SW
2. No Obvious signs of cracking observed on the pavement section
3. Logged by N. Weikel on February 12, 2020</td><td>4 inches total</td></tr>
</table>

Figure D-1

<table>
<tr><th colspan="2">PG-2</th></tr>
<tr><td>Location: 47.148548, -122.55781 (Approximately 9025 Washington Blvd SW)
Subgrade Condition: Very dense, silty fine to coarse sand with abundant gravel</td><td>Pavement Thickness</td></tr>
<tr><td>Photo of asphalt core at PG-2 location not available.
No obvious signs of layering.</td><td>6 inches</td></tr>
<tr><td>Notes:
1. Boring PG-2 cored/drilled in center lane of Washington Boulevard SW
2. No Obvious signs of cracking observed on the pavement section
3. Logged by N. Weikel on February 12, 2020</td><td>6 inches total</td></tr>
</table>

Figure D-2

<table>
<tr><th colspan="2">PG-3</th></tr>
<tr><td>Location: 47.148531, -122.554318 (Approximately 8807 Washington Blvd SW)
Subgrade Condition: Very dense, silty fine sand with abundant gravel</td><td>Pavement Thickness</td></tr>
<tr><td rowspan="2">
</td><td>3 inches</td></tr>
<tr><td>1½ inches
(not pictured)</td></tr>
<tr><td colspan="2">Thin layer of fabric</td></tr>
<tr><td>
</td><td>1½ inches</td></tr>
<tr><td>Notes:
1. Boring PG-3 cored/drilled in center lane of Washington Boulevard SW
2. No Obvious signs of cracking observed on the pavement section
3. Logged by N. Weikel on February 12, 2020</td><td>6 inches total</td></tr>
</table>

Figure D-3

<table>
<tr><th colspan="2">PG-4</th></tr>
<tr><td>Location: 47.14852, -122.546019 (Approximately 8210 Washington Blvd SW)
Subgrade Condition: Very dense, silty fine sand with abundant gravel</td><td>Pavement Thickness</td></tr>
<tr><td rowspan="3">

Photo of entire asphalt core at PG-4 location</td><td>2½ inches</td></tr>
<tr><td>Thin layer of fabric</td></tr>
<tr><td>3 inches</td></tr>
<tr><td>Notes:
1. Boring PG-4 cored/drilled in center lane of Washington Boulevard SW
2. No Obvious signs of cracking observed on the pavement section
3. Logged by N. Weikel on February 12, 2020</td><td>5½ inches total</td></tr>
</table>

Figure D-4

<table>
<tr><th colspan="2">PG-5</th></tr>
<tr><td>Location: 47.148585, -122.54323 (Approximately 7920 Washington Blvd SW)
Subgrade Condition: Very dense, silty fine sand with abundant gravel</td><td>Pavement Thickness</td></tr>
<tr><td>
</td><td>2½ inches</td></tr>
<tr><td></td><td>Thin layer of fabric</td></tr>
<tr><td>
</td><td>1½ inches</td></tr>
<tr><td>Notes:
1. Boring PG-5 cored/drilled in center lane of Washington Boulevard SW
2. No Obvious signs of cracking observed on the pavement section
3. Logged by N. Weikel on February 12, 2020</td><td>4 inches total</td></tr>
</table>

Figure D-5

<table>
<tr><th colspan="2">PG-6</th></tr>
<tr><td>Location: 47.14762, -122.53906 (Approximately 12108 Gravelly Lake Dr SW)
Subgrade Condition: Medium dense, silty fine sand/fine sandy silt with gravel</td><td>Pavement Thickness</td></tr>
<tr><td></td><td>2 inches</td></tr>
<tr><td></td><td>4½ inches</td></tr>
<tr><td>GRAVEL</td><td>½ inch</td></tr>
<tr><td rowspan="2"></td><td>2 inches asphalt</td></tr>
<tr><td>6 inches concrete</td></tr>
<tr><td>Notes:
1. Boring PG-6 cored/drilled in center lane of Gravelly Lake Dr SW
2. No Obvious signs of cracking observed on the pavement section
3. Logged by C. Venturino on February 13, 2020</td><td>18 inches total</td></tr>
</table>

Figure D-6

<table>
<tr><th colspan="2">PG-7</th></tr>
<tr><td>Location: 47.142446, -122.536492 (Approximately 12613 Gravelly Lake Dr)
Subgrade Condition: Dense, silty fine sand with trace gravel</td><td>Pavement Thickness</td></tr>
<tr><td rowspan="2">
Photo of entire asphalt core at the PG-7 location</td><td>2 inches</td></tr>
<tr><td>3 inches</td></tr>
<tr><td>Notes:
1. Boring PG-7 cored/drilled in center lane of Gravelly Lake Dr SW
2. No Obvious signs of cracking observed on the pavement section
3. Logged by C. Venturino on February 13, 2020</td><td>5 inches total</td></tr>
</table>

Figure D-7

<table>
<tr><th colspan="2">PG-8</th></tr>
<tr><td>Location: 47.14114, -122.528968 (Approximately 12789 Gravelly Lake Dr SW)
Subgrade Condition: Very dense, silty fine to medium sand with some gravel</td><td>Pavement Thickness</td></tr>
<tr><td rowspan="2">
Photo of entire asphalt core at PG-8 location</td><td>2 inches</td></tr>
<tr><td>3 inches</td></tr>
<tr><td>Notes:
4. Boring PG-8 cored/drilled in center lane of Gravelly Lake Dr SW
5. No Obvious signs of cracking observed on the pavement section
6. Logged by C. Venturino on February 13, 2020</td><td>5½ inches total</td></tr>
</table>

Figure D-8