PanGEO INCORPORATED
Geotechnical & Earthquake Engineering Consultants

September 20, 2023
PanGEO Project No. 23-284

Robin and Ken Phillips
1945 – 82nd Avenue SE
Mercer Island, WA 98040

Subject: Geotechnical Engineering Report
Proposed East Pier Dredging
1945 82nd Avenue SE
Mercer Island, Washington 98040

Dear Ken and Robin:

As requested, PanGEO, Inc. is pleased to present the following geotechnical report to assist you and your project team with the planning, permitting and implementation of the proposed dredging project along the east side of the existing east pier located at your property on Mercer Island, Washington. In preparing this report, we reviewed existing subsurface information in the vicinity of the site, performed a site reconnaissance and a limited subsurface exploration program, and reviewed the proposed dredging plans prepared by Waterfront Construction, Inc.

Based on the results of our study, in our opinion the proposed dredging plan is feasible from the geotechnical standpoint and will not adversely affect the existing piles that support the pier, or the adjacent properties.

We appreciate the opportunity to be of service.

Sincerely,

Jon C. Rehkopf, P.E.
Principal Geotechnical Engineer

Enclosed: Geotechnical Engineering Report

3213 Eastlake Avenue East, Suite B
Seattle, WA 98102
T. (206) 262-0370

TABLE OF CONTENTS

List of Figures:

Appendix A Existing Boring Logs

GEOTECHNICAL ENGINEERING REPORT
PROPOSED EAST PIER DREDGING
1945 82ND AVENUE SE
MERCER ISLAND, WASHINGTON

1.0 GENERAL

As requested, PanGEO, Inc. is pleased to present this geotechnical report to assist the project team with the planning, permitting, and implementation of the proposed dredging project at 1945 82nd Avenue SE, in Mercer Island, Washington. This study was performed in general accordance with our mutually agreed scope of services outlined in our proposal dated August 16, 2023, which was subsequently authorized on that same date. Our scope of services included reviewing readily available geologic and geotechnical data in the vicinity of the site, conducting a site reconnaissance and a limited subsurface exploration program, and preparing this report.

2.0 SITE AND PROJECT DESCRIPTION

The site is located at 1945 - 82nd Avenue Southeast, at the north end of Mercer Island, Washington, as depicted in Figure 1. The site, which is situated along the Lake Washington shoreline, is accessed by a steep private driveway that extends about 500 feet north from 82nd Avenue Southeast.

PanGEO previously performed a geotechnical study in 2015 to support the design of the driveway realignment, which included the installation of permanent soldier pile retaining walls along the driveway alignment in the steep, southern portion of the site. PanGEO also previously prepared a geotechnical report for the new single-family residence at the site.

The specific focus of our current study is the eastern-most pier located at the subject site. The eastern pier extends a total length of about 128 feet into Lake Washington. The pier is approximately 6 feet wide, with a wider platform at the end of the pier measuring about 19 feet by 12½ feet. The pier is supported by driven steel pipe piles, the length of which are not known.

Based on our field measurements, at the time of our site visit (August 31, 2023) the water along the east side of the pier ranged from about 5 feet to 6 feet deep.

Plates 1 and 2 on the following page depict current site conditions.

Plate 1. *Looking north at east pier. Dredging will occur along the right side of the pier.*

Plate 2. *Looking south at east pier. Dredging will occur along the left side of the pier.*

The proposed project will consist of dredging along the east side of the existing east pier. We understand the dredging is planned to lower the mudline about four feet to allow access for larger vessels to dock along the pier without running aground. No work is planned for the existing pier.

We understand that the City of Mercer Island is requiring a geotechnical report to support the dredging design and address any geologic hazards at the site that may impact the project.

The conclusions and recommendations in this report are based on our understanding of the proposed project, which is in turn based on the project information provided. If the above project description is incorrect, or the project information changes, we should be consulted to review the recommendations contained in this study and make modifications, if needed. PanGEO should be retained to provide a review of the final design to confirm that our geotechnical recommendations have been correctly interpreted and adequately implemented in the construction documents.

3.0 SUBSURFACE CONDITIONS

3.1 SITE GEOLOGY

According to the geologic map of Mercer Island (Troost and Wisher, 2006), the project site is underlain by older glacial and non-glacial deposits ranging from very dense coarse grain deposits consisting of sand and gravel, to hard, fine grain deposits of silt and clay. The map indicates that the underlying older deposits are capped by Vashon Glacial Till, an over-consolidated heterogeneous mixture of silt, sand and gravel. Lastly, recent lake deposits are mapped along the shoreline and the lower, north half of the site.

3.2 PREVIOUS SUBSURFACE EXPLORATIONS

To understand the subsurface conditions at the site, we reviewed the results of test borings that PanGEO previously advanced in the upland portion of the subject site to support the design of the new residence. In particular, we reviewed test borings PG-3 and PG-4 which were advanced along the shoreline near the subject east pier. The borings were advanced to a depth of 19 feet below the ground surface.

The approximate locations of the previous test borings PG-3 and PG-4 are shown on the attached Figure 2 (Site and Exploration Plan). The summary test borings logs are included in Appendix A.

3.3 SOIL CONDITIONS

We anticipate that the soil conditions in the proposed dredging location may be similar to the underlying soils encountered in Boring PG-3 and PG-4, which were advanced on the subject property near the shoreline.

Boring PG-3 and PG-4 generally encountered from 2½ to 3 feet of medium dense, silty fine sand with trace to some gravel and roots, which we interpreted to be fill over about 1½ to 2 feet of stiff to very stiff sandy silt and clay, which exhibited some disturbed texture, and was interpreted to be fill or disturbed soil. At a depth of about 4½ feet in both borings, stiff to very stiff clayey silt was encountered, which extended to the termination depth of the holes. At a depth of about fifteen feet below the existing ground surface, the clayey silt became hard. We interpreted the encountered soils to be the mapped older glacially consolidated deposits (glaciolacustrine deposits).

We anticipate the soils underlying the proposed dredge area may consist of loose to medium dense lake deposits over the native stiff to very stiff clayey silt which was observed in test borings PG-3 and PG-4, and mapped in the area.

Test Probing

To gain additional information regarding the soil conditions at relatively shallow depths below the mudline along the east pier, we conducted a limited subsurface exploration program that consisted of utilizing a 3/8-inch diameter extendable steel hand probe to evaluate the density or consistency of the soils below the mudline. The probe was advanced by hand from the dock at the six locations shown on the attached Figure 2.

At each location the depth interval that required easy to moderate effort, followed by significant effort, was recorded to establish a qualitative description of the density of the underlying soils. The results of our probing are summarized in Table 1 below. As noted from the table, in general, a layer of loose to medium dense soils extends from approximately 3 to 5 feet below the mudline. Below this layer of loose to medium dense soil, a layer of medium dense to dense/stiff to hard soils ranged in thickness from about 1 to 3 feet or more. The maximum depth of probing was about 8 feet below the mudline.

Table 1 – Results of Test Probe Program		
Probe Number	**Thickness of Loose to Medium Dense Soil Below Mudline (feet)**	**Depth Below Mudline to Probe Refusal (feet)**
P-1	2.7	3.6
P-2	2.8	5.0
P-3	3.7	4.6
P-4	5.0	7.8
P-5	5.6	7.1
P-6	5.2	+8

4.0 GEOLOGIC HAZARD AREAS

Based on our review of the City of Mercer Island GIS maps, the upland portion of the project site includes the following geologic hazards: potential landslide hazard area, seismic hazard area, and erosional hazard area.

4.1 POTENTIAL LANDSLIDE HAZARDS

The subject site is mapped within a potential landslide hazard area according to the City of Mercer Island's Geologic Hazards Map. The map indicates that slopes of 40% or more are present at the site, as well as landslide and mass wasting deposits.

Because the proposed project only includes dredging in the water, away from the steep slopes and mapped landslide hazard area, in our opinion the currently proposed dredging project is feasible from a geotechnical engineering standpoint and will not adversely affect the overall stability of the site or adjacent properties, provided the recommendations outlined in this report are followed.

4.2 SEISMIC HAZARDS

Based on our review of the City of Mercer Island's Geologic Hazards Maps, the shoreline area of the subject site is mapped as a seismic hazard area. The City of Mercer Island Code defines seismic hazard areas as those areas subject to risk of damage as a result of earthquake-induced ground shaking, slope failure, soil liquefaction or surface faulting.

Because the proposed project only includes the removal of limited amounts of soils below the mudline, in our opinion the currently proposed dredging project will not be significantly affected by the potential liquefaction of site soils or associated seismic hazards.

4.3 EROSION HAZARDS

The subject site is mapped within a potential erosion hazard area according to the City of Mercer Island's Geologic Hazards Map. Because the project will only include over-water work, the erosion of upland soils will not occur. We understand that Best Management Practices will be used to mitigate the potential of sediment leaving the work area during the dredging operation. As such, based on our understanding of the project, in our opinion the erosion hazard at the site is negligible, and sediment transport in the water during dredging can be effectively mitigated using Best Management Practices.

4.4 SUMMARY

It is our opinion that the proposed project as currently planned is feasible from a geotechnical engineering standpoint, and will not adversely affect the mapped geologic hazards at the site, and the geologic hazards will not adversely impact the proposed dredging project.

5.0 GEOTECHNICAL CONCLUSIONS & RECOMMENDATIONS

5.1 DREDGING CONFIGURATION

We understand that the proposed dredging plan will deepen the lake bottom along the east side of the eastern pier on the order of about 4 feet, to allow a total depth of water of 10 to 11 feet below OHW.

Based on our understanding of the soil conditions within the dredged area, we recommend that the dredging configuration side slopes be sloped no steeper than 2H:1V. Steeper slopes would likely experience sloughing in the near future, which could result in the loss of the

dredged depth. Slopes flatter than 2H:1V may be used, and would have a lower risk of sloughing over the long term.

5.2 Potential Impact on Adjacent Pier

Based on our review of the project plans, the top of the proposed dredge slope will be located a minimum of 3 feet horizontal from the existing driven piles that support the east pier. Considering the results of our test probing program found from 3 to 5 feet of loose to medium dense sediment below the mudline, and the proposed maximum removal of about 4 feet of sediment, the sediment that will be removed adjacent to the pier will be loose to medium dense in nature, and therefore are not providing appreciable resistance to the existing pier piles. Although the total depth of the piles is not known, based on the loose nature of the sediment that will be dredged, in our opinion the dredging will not adversely impact the performance of the existing pier piles.

5.3 Erosion & Silt Containment Considerations

We understand that all work will occur over the water, with no disturbance to occur to the upland area of the site. As such, no erosion is expected to occur, and no erosion control measures on the upload area would be required.

Based on our review of the preliminary project plans, the contractor will utilize a temporary floating silt containment fence around the dredge area to mitigate the potential for sediment to transport off-site. In our opinion the proposed silt containment fence represents an acceptable silt containment measure. As with all erosion control measures, the performance of the silt containment fence should be monitored during construction, and adjustments made as necessary, to insure it is functioning as intended.

6.0 STATEMENT OF RISK

The upland portion of the site is mapped as a geologic hazard area by the City of Mercer Island. Although the proposed dredging work will occur over water, outside of the mapped hazard areas, due to the proximity of the mapped hazard areas, we anticipate that the City of Mercer Island may require the following Statement of Risk.

Per Mercer Island City Code, development within geologic hazard areas and critical slopes may occur if the geotechnical engineer provides a statement of risk with supporting documentation indicating that one of the following conditions can be met:

a. The geologic hazard area will be modified, or the development has been designed so that the risk to the lot and adjacent property is eliminated or mitigated such that the site is determined to be safe; or

b. An evaluation of site-specific subsurface conditions demonstrates that the proposed development is not located in a geologic hazard area; or

c. Development practices are proposed for the alteration that would render the development as safe as if it were not located in a geologic hazard area; or

d. The alteration is so minor as not to pose a threat to the public health, safety, and welfare.

It is our opinion that Criterion A, C, and D can be met provided that the development is designed and constructed in accordance with the recommendations in this report.

In our opinion the proposed dredging project will not increase the risk to the subject lot or adjacent property, and the site can be considered safe, thus meeting Criterion A.

In addition, in our opinion Criterion C can be met through best management practices during construction, including the proper use of a silt containment fence.

Lastly, due to the limited amount of proposed dredging, in our opinion Criterion D applies to the subject project as well.

7.0 ADDITIONAL SERVICES

PanGEO is available to provide additional consultation during design and permitting, and to monitor geotechnical aspects of construction, if requested.

8.0 CLOSURE

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

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 services specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances. We are not mold consultants nor are our recommendations to be interpreted as being preventative of mold development. A mold specialist should be consulted for all mold-related issues.

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 work with you on this project. If you have any questions, please do not hesitate to contact our office.

Sincerely,

PanGEO, Inc.

Jon C. Rehkopf, P.E.
Principal Geotechnical Engineer
jrehkopf@pangeoinc.com

9.0 REFERENCES

PanGEO, (2015). *Log of Test Boring PG-3 and PG-4, 1935 82nd Avenue SE, Mercer Island, WA*, July 31, 2015, project number 07-105.300.

Troost, Kathy G, and Wisher, Aaron P., (2006). *Geologic Map of Mercer Island, Washington*. October 2006.

Not to Scale

Base Map: King County iMap

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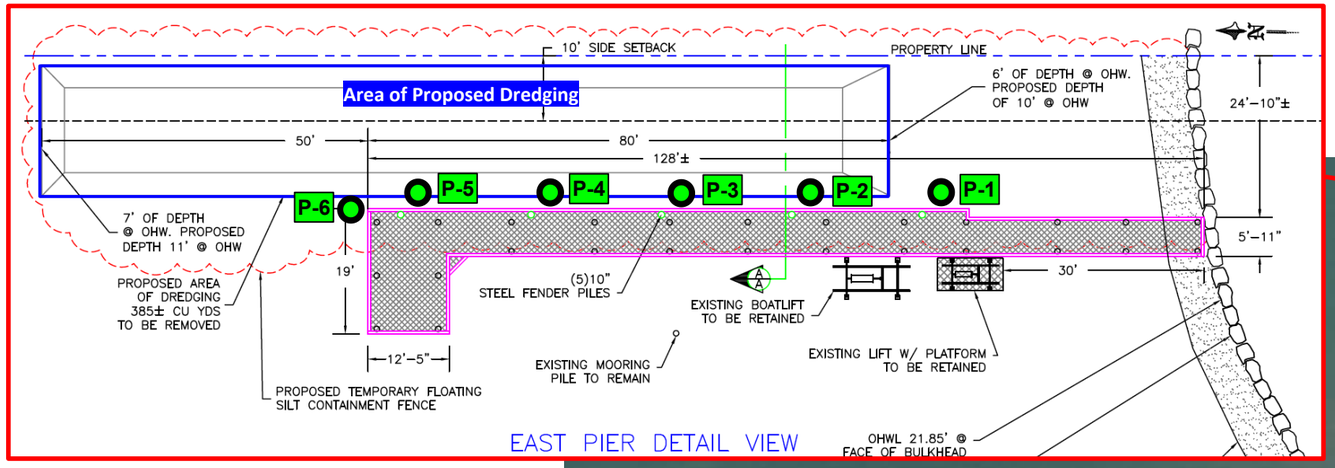
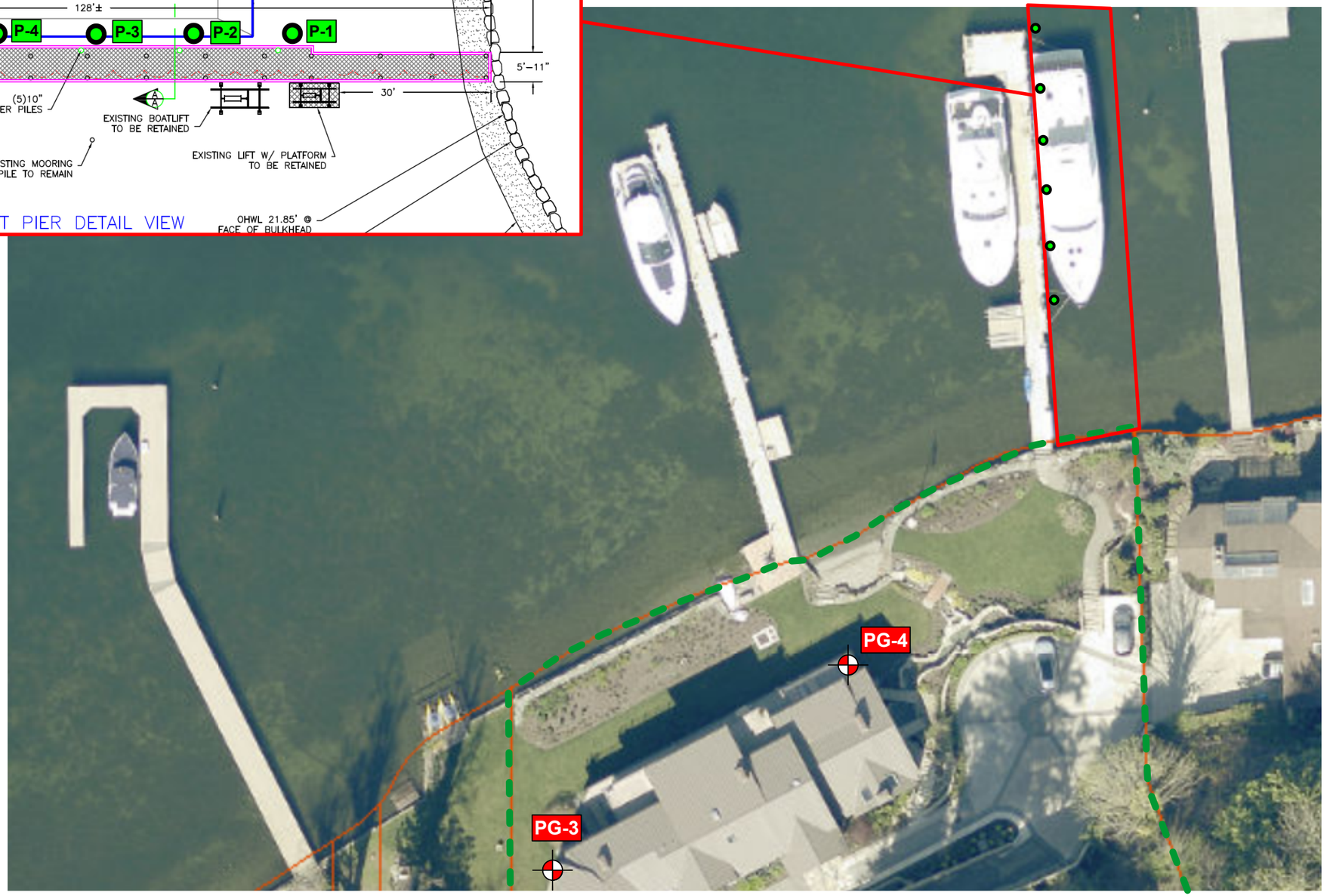
Proposed Dredging
1945 82nd Avenue SE
Mercer Island, Washington

VICINITY MAP

Project No.	Figure No.
23-284	1



Approx. Scale
1" = 20'



Notes:

1. Air photo obtained from King County iMAP.
2. East Pier Detail View provided by Waterfront Construction.

Legend:

- Approx. Borehole Location (*PanGEO 2015)*
- Approx. Test Probe Location *(This Study)*
- Approx. Property Boundary

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PanGEO INCORPORATED	**Proposed Dredging** **1945 82nd Avenue SE** **Mercer Island, Washington**	**SITE AND EXPLORATION PLAN** Project No. **23-284** / Figure No. **2**

APPENDIX A

EXISTING EXPLORATION 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 SILT
		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.

CBR	California Bearing Ratio
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)

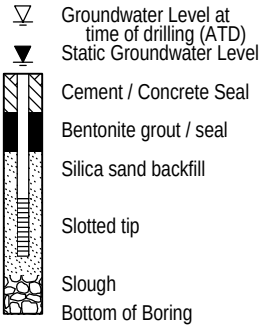

Thin wall (Shelby) tube


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

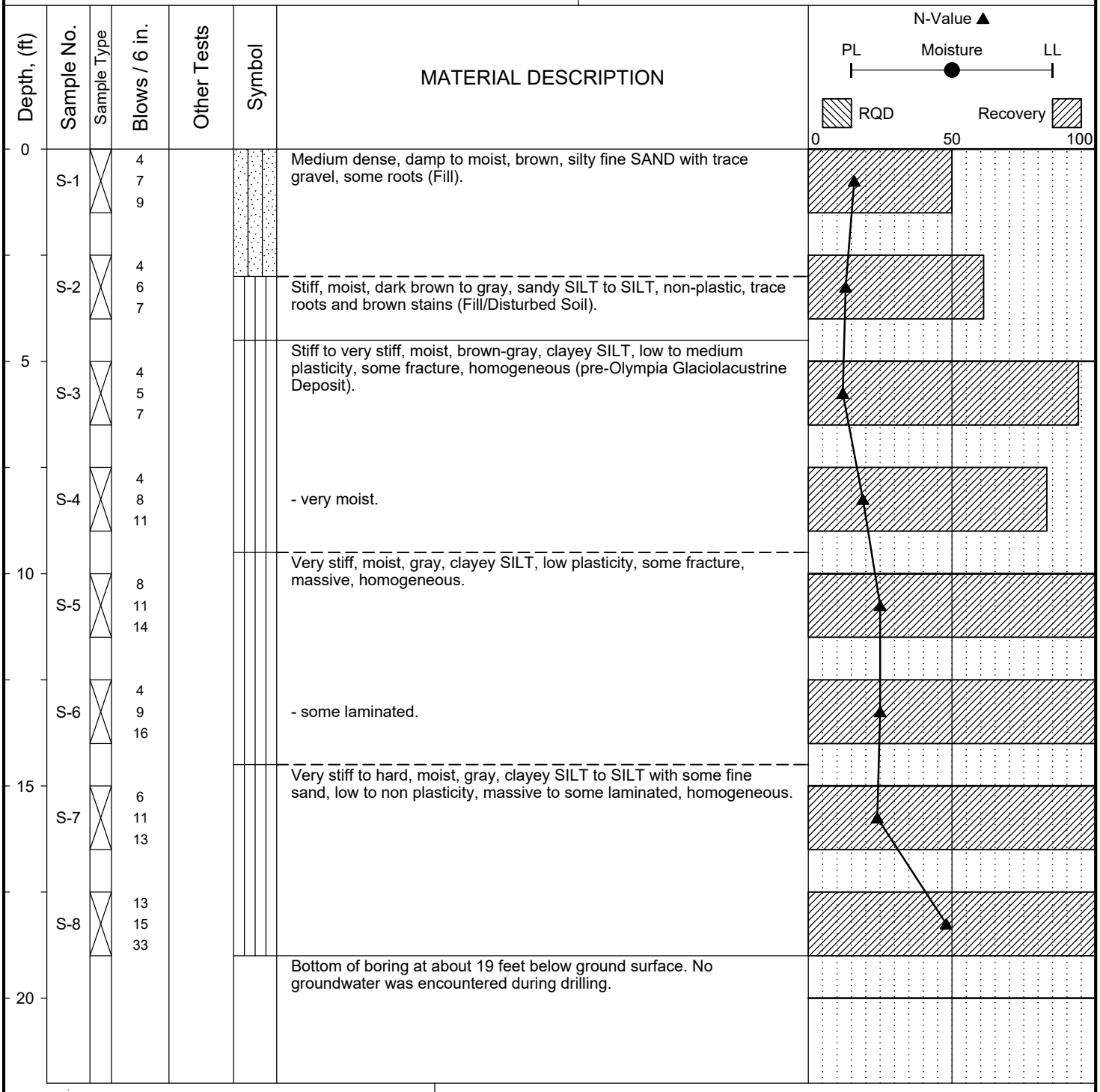
Dry	Dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

PanGEO INCORPORATED
Phone: 206.262.0370

Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project:	Proposed Residence	Surface Elevation:	24.0ft
Job Number:	07-105.300	Top of Casing Elev.:	
Location:	1935 82nd Avenue SE, Mercer Island, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



Completion Depth:	19.0ft
Date Borehole Started:	7/31/15
Date Borehole Completed:	7/31/15
Logged By:	J. Chen
Drilling Company:	CN Drilling

Remarks: Boring was drilled with a Acker portable drill rig. Standard Penetration Test (SPT) sampler driven with a 140 lb hammer using a rope and cathead dropping 30 inches per stroke.

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LOG OF TEST BORING PG-3

Figure A-4

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

Project:	Proposed Residence	Surface Elevation:	24.0ft
Job Number:	07-105.300	Top of Casing Elev.:	
Location:	1935 82nd Avenue SE, Mercer Island, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0	S-1		4 5 7			Medium dense, damp to moist, dark brown to brown, silty fine SAND with some gravel, trace roots (Fill).
	S-2		3 8 9			Very stiff, moist, gray, sandy CLAY with trace gravel, low plasticity (Fill/Disturbed Soil). - 3" interbedded fine sand layer with trace gravel.
5	S-3		4 7 9			Very stiff, moist, brown-gray, silty CLAY, medium to low plasticity, some fracture, homogeneous, trace weathering (pre-Olympia Glaciolacustrine Deposit). - very moist.
	S-4		4 7 10			
10	S-5		8 11 11			Very stiff, moist, gray, clayey SILT, low plasticity, some fracture, massive, homogeneous.
	S-6		8 12 16			- some laminated.
15	S-7		8 12 19			Hard, moist, gray, clayey SILT, low to non plasticity, massive, homogeneous.
	S-8		7 15 17			
20						Bottom of boring at about 19 feet below ground surface. No groundwater was encountered during drilling.

N-Value ▲

PL Moisture LL

RQD Recovery

0 50 100

Completion Depth:	19.0ft
Date Borehole Started:	7/31/15
Date Borehole Completed:	7/31/15
Logged By:	J. Chen
Drilling Company:	CN Drilling

Remarks: Boring was drilled with a Acker portable drill rig. Standard Penetration Test (SPT) sampler driven with a 140 lb hammer using a rope and cathead dropping 30 inches per stroke.

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LOG OF TEST BORING PG-4

Figure A-5

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