PanGEO
INCORPORATED
Geotechnical & Earthquake Engineering Consultants

April 29, 2021
File No. 21-145

Mr. Chinmay Dubey
2364 Hobart Avenue SW
Seattle, WA 98116

Subject: **Geotechnical Engineering Report**
Proposed Development
8434 SE 39th Street, Mercer Island, WA

Dear Mr. Dubey,

Please find attached our geotechnical engineering report for the proposed project at the subject site in Mercer Island, Washington. This report documents the subsurface conditions at the site and presents our geotechnical engineering design recommendations for the proposed residence(s).

In summary, the test borings advanced at the site encountered 4½ to 7 feet of fill overlying medium dense to dense sand with gravel. Based on the soil conditions, in our opinion the proposed structure(s) may be supported by conventional shallow footings bearing on the native competent soils, or compacted structural fill placed on the competent native soils. Temporary excavations may be sloped as steep as 1H:1V (Horizontal:Vertical). Where space is not available for unsupported cuts, temporary shoring consisting of cantilever soldier pile walls will be feasible to support the excavations.

We appreciate the opportunity to be of service. Please call if there are any questions.

Sincerely,

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

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

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ATTACHMENTS:

GEOTECHNICAL ENGINEERING REPORT
PROPOSED DEVELOPMENT
8434 SOUTHEAST 39TH STREET
MERCER ISLAND, WASHINGTON

1.0 GENERAL

This report presents the results of a geotechnical engineering study that was undertaken to support the design and construction of the proposed residence(s) in Mercer Island, Washington. This study was performed in general accordance with our mutually agreed scope of services outlined in our proposal dated March 18, 2021, which was subsequently approved by you on March 22, 2021. Our scope of services included reviewing readily available geologic and geotechnical data, drilling three test borings, conducting a site reconnaissance, performing engineering analysis, and developing the conclusions and recommendations presented in this report.

2.0 SITE AND PROJECT DESCRIPTION

The project site is located at 8434 SE 39th Street in Mercer Island, Washington, as shown on Figure 1, Vicinity Map. The subject site is rectangular in shape, and based on the project survey, has an area of approximately 17,100 square-feet. The site is bounded to the south by SE 39th Street, and by single-family residences on all other sides. The site is currently occupied by a single-family residence that is located in the southern portion of the site (see Figure 2, Site and Exploration Plan).

Based on a review of the topographic survey of the site, and our observations, the site generally slopes down at gentle angles from east to west with an average gradient of about 9 percent and a total vertical relief of about 8 feet (see topographic contours on Figure 2). Site vegetation consists of landscaping plants and lawn areas. Current site conditions are shown on Plates 1 and 2 on the following page.

We understand that the proposed project consists of the demolition of the existing structure and the construction of a new single-family residence. We understand that you may also consider subdividing the parcel, and constructing a second single-family residence at the site. Conceptual design drawings or site plans are not currently available, but we anticipate that one house would be constructed in the northern portion of the parcel, and one in the southern portion of the parcel due to the shape of the lot. If basements will be located in close proximity to property lines, temporary shoring may be needed to support the temporary excavation and protect the adjacent properties.

Plate 1*. View of the south side of subject property, looking north from SE 39th St.*

Plate 2*. View of north side of subject property, looking approximately south.*

Based on review of the City of Mercer Island Geologic Hazard maps, there are no geologic hazards (i.e., potential landslide, seismic, erosion) mapped at the site.

The conclusions and recommendations in this report are based on our understanding of the proposed development, 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. In any case 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 EXPLORATIONS

3.1 TEST BORINGS

Our subsurface exploration program consisted of drilling three test borings (PG-1 through PG-3) at the approximate locations shown on Figure 2 on March 31, 2021 using a CAT track drill rig operated by Geologic Drill Partners, Inc. under a subcontract to PanGEO. The borings were advanced to depths ranging from 16½ feet to about 26 feet below existing ground surfaces.

The drill rig was equipped with a 6-inch outside diameter hollow stem auger, and soil samples were obtained from the borings at 2½- and 5-foot depth intervals in general accordance with Standard Penetration Test (SPT) sampling methods (ASTM test method D-1586) in which the samples are obtained using a 2-inch outside diameter split-spoon sampler. The sampler was driven into the soil a distance of 18 inches using a 140-pound weight falling a distance of 30 inches. The number of blows required for each 6-inch increment of sampler penetration was recorded. The number of blows required to achieve the last 12 inches of sample penetration is defined as the SPT N-value. The N-value provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils.

A geologist from PanGEO was present throughout the field exploration program to observe the drilling, assist in sampling, and to document the soil samples obtained from the borings. The soil samples retrieved from the borings were described using the system outlined on Figure A-1 of Appendix A and the summary boring logs are included as Figures A-2 through A-4.

3.2 Laboratory Testing

Representative soil samples obtained from our test borings were selected for laboratory tests to determine grain size distribution. The summary test results from the grain size analysis are included in Appendix B.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Site Geology

Based on our review of The Geologic Map of Mercer Island (Troost and Wisher, 2006), the subject property is underlain by Vashon till (Map Unit Qvt). Vashon till is described by Troost et al., as a dense to very dense, compact diamict of silt, sand, and gravel glacially transported and overridden by the Vashon ice sheet. Vashon till typically exhibits low compressibility and high strength characteristics in its undisturbed state.

4.2 Soil Conditions

In summary, the soils observed in the borings generally consisted of loose to medium dense fill overlying medium dense to very dense silty sand with gravel that we interpreted to be the mapped glacial till. A description of the soil units encountered in our test borings is presented below. Detailed descriptions of the encountered soils in our test borings can be seen in our boring logs included in Appendix A.

> **Fill:** Beneath approximately 3 to 4 inches of topsoil and grass, loose to medium dense, silty fine sand with varying amounts of gravel and organic content was observed in all three borings. This soil unit extended to about 7 feet below the existing ground surface in PG-1 advanced near the northeast property corner, and 4½ feet below grade in PG-2 and PG-3. We interpreted this unit to be fill based on the relatively loose nature of the material, disturbed texture, and the presence of organics.

> **Weathered Till:** Underlying the fill, test boring PG-3 encountered medium dense, silty sand with trace gravel that extended to a depth of 7 feet below grade. We interpreted this unit to be the upper weathered portion of the mapped glacial till.

> **Glacial Till:** Underlying the fill material and weathered till, our test borings encountered medium dense to very dense, well-graded gravelly sand with silt, and silty gravelly sand that extended to the maximum exploration depth of about 16½ feet below grade in borings PG-1 and PG-2, and about 26 feet below grade in boring

PG-3. We interpret these soils as glacial till, which is consistent with the geologic mapping of the area.

Our subsurface descriptions are based on the conditions encountered at the specific locations 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.

4.3 Groundwater Conditions

Groundwater was not encountered within the termination depth of our test borings at the time of drilling. However, seasonal perched groundwater may occur just above the contact between the existing fill and the underlying low permeability dense glacial till. Groundwater levels will vary depending on the season, local subsurface conditions, and other factors. Groundwater levels are normally highest during the winter and early spring (typically October through May).

5.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

5.1 Seismic Design Considerations

Site Class: We anticipate that the project will be designed in accordance with the 2018 edition of the International Building Code (IBC). We recommend a seismic site class D (Stiff Soil) be used for design of the structure(s).

Liquefaction Potential: Based on the presence of dense to very dense glacially overridden deposits underlying the site, and lack of groundwater encountered in the explorations, it is our opinion that the potential for earthquake-induced soil liquefaction is considered to be negligible. In our opinion, special design considerations associated with soil liquefaction are not necessary for this project.

5.2 Building Foundations

Based on the subsurface conditions encountered at our test boring locations, it is our opinion that conventional footings are appropriate for supporting the proposed structures. All footings should be placed on undisturbed native soils, or on properly compacted structural fill placed on undisturbed native soils. All loose soils below the footings should be removed. As previously discussed, 4½ to 7 feet of fill was encountered in our test borings. Depending on the design footing elevations, over-excavation may be needed to remove the existing fill. All footing over-excavation should be backfilled with properly compacted granular structural fill, as described in Section 6.0 of this report.

Allowable Bearing Pressure – In general, we anticipate the footing subgrade to mostly consist of medium dense to dense native sand with gravel (glacial till). As such, footings constructed as discussed above may be sized using a maximum allowable bearing pressure of 3,000 psf. For allowable stress design, the recommended allowable bearing pressure may be increased by 1/3 for transient conditions such as wind and seismic loadings. Continuous and individual spread footings should have minimum widths of 18 and 24 inches, respectively. Footings should be placed at least 18 inches below final exterior grade. Interior footings should be placed at least 12 inches below the top of slab.

Where space may be limited for an unsupported open cut, it may be necessary to use L-shaped perimeter footings in order to conserve space and to allow the temporary excavations to be made within the property limits.

Over-Excavation & Replacement with Structural Fill – At locations where the native, medium dense to dense glacial till is not exposed at the footing subgrade elevation, the fill should be over-excavated and replaced with properly compacted structural fill, such as crushed rock or recycled concrete. The over-excavation should extend horizontally out from the edge of the footing a distance equal to half of the over-excavation depth. We recommend that imported granular structural fill be placed in 8-inch thick lifts below the footings and compacted to a dense condition with a hoe-pac or jumping jack-type compactor. If density tests will be performed, the test results should indicate at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557. We do not recommend the re-use of on-site soils as structural fill below the footings. Lean-mix concrete may also be used to backfill over-excavations. If lean-mix is used, the over-excavation only would need to extend 1-foot wider than the footing.

Lateral Resistance **–** Lateral forces from wind or seismic loading may be resisted by a combination of passive earth pressures acting against the embedded portions of the foundations and walls, and by friction acting on the base of the foundations. Passive resistance values may be determined using an equivalent fluid weight of 300 pounds per cubic foot (pcf). This value includes a factor safety of at least 1.5 assuming that densely compacted structural fill will be placed adjacent to the sides of the foundation. A friction coefficient of 0.35 may be used to determine the frictional resistance at the base of the foundation. This coefficient includes a factor of safety of approximately 1.5. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches of soil should be neglected.

***Foundation Performance* –** Total and differential settlements are anticipated to be within tolerable limits for foundation designed and constructed as discussed above. For the proposed building supported by conventional footings bearing on competent native soils and structural fill/lean-mix concrete, the building settlement under static loading conditions is estimated to be less than approximately one inch, and differential settlement should be on the order of about ½ inch or less. Most settlement should occur during construction as loads are applied.

Footing Excavation and Subgrade Protection – All footing subgrades should be carefully prepared. Any loose or softened soil should be removed from the footing excavations and replaced with granular structural fill such as crushed rock or recycled concrete. The exposed footing subgrades should be observed by PanGEO to confirm that the subgrade is consistent with the expected conditions and adequate to support the proposed residence.

Some of the site soils are moisture sensitive, and can be easily disturbed when exposed to moisture. Groundwater seepage, wet weather, and construction activities could soften/loosen the exposed subgrades. As a result, depending on seepage rates and the weather condition at the time of footing construction, it may be necessary to place 2 to 3 inches of lean-mix concrete or 4 to 6 inches of clean crushed rock on the exposed footing subgrades to protect against moisture and disturbance.

Perimeter Footing Drain – We recommend that a 4-inch diameter perforated pipe embedded in pea gravel or washed rock and wrapped in geotextile filter fabric be installed at the base of the footings to direct collected water to an appropriate outlet. Under no circumstances should roof downspout drain lines be connected to the footing drain system. Roof downspouts must be separately tightlined to an appropriate discharge. Cleanouts should be installed to allow for periodic maintenance of the footing drain and downspout tightline systems.

5.3 BELOW-GRADE WALLS

Below-grade walls, such as basement and site retaining walls, should be designed to resist the lateral earth pressures exerted by the soils behind the wall. Proper drainage provisions should also be provided to intercept and remove groundwater that may be present behind the walls. Our recommendations for the design and construction of below-grade walls are presented below.

5.3.1 Lateral Earth Parameters

The below grade portions of the walls should be designed for an earth pressure based upon an equivalent fluid weight of 35 pcf for a wall that is allowed to yield (active condition), and 50 pcf for a wall that is restrained (at-rest condition). For the seismic condition, we recommend a uniform lateral earth pressure of at least 10H psf (where H is the height of the below grade portion of the wall) be added to the static pressure for sizing the basement walls for the ultimate condition. The recommended lateral pressures assume that adequate wall drainage will be incorporated into the design and construction of the walls to prevent the development of hydrostatic pressure.

5.3.2 Surcharge

Below-grade walls should be designed to accommodate permanent surcharge pressures if the surface load is located within the height dimension of the wall. Similarly, surcharge loads from construction equipment or soil/material stockpiles may need to be considered in the retaining wall design. The diagram in Figure 3 may be used to calculate the horizontal pressure on the retaining walls from vertical surcharge loads.

5.3.3 Wall Drainage

Provisions for permanent control of subsurface water should be incorporated into the design and construction of below-grade walls. For walls constructed with conventional free-draining backfill, a footing drain consisting of a 4-inch diameter perforated pipe embedded in at least 12 inches of washed gravel wrapped with a geotextile fabric should be placed at the base of the wall footings. We recommend that prefabricated drainage mats, such as Mirafi 6000 or equivalent, be installed behind the basement walls to promote wall drainage.

Where the below-grade wall will be constructed against a shoring wall (see Section 5.5.3) we recommend that prefabricated drainage mats, such as Mirafi 6000 or equivalent, be installed behind the walls (full face coverage) and the collected water should be directed through weep holes inside the building beneath the floor slab and tight-lined to an appropriate outlet.

5.3.4 Wall Backfill

Wall backfill should consist of free draining granular soils. It is our opinion that the fines content of the on-site soils it too high to be considered for use as wall backfill. Imported wall backfill should consist of granular soils such as City of Seattle Type 17 mineral aggregate or a PanGEO approved equivalent.

Wall backfill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557 (Modified Proctor). Within 5 feet of the wall, the backfill should be compacted to 90 percent of the maximum dry density.

5.4 Floor Slabs

The floor slabs for the proposed residence(s) may be constructed using conventional concrete slab-on-grade floor construction. The floor slabs should be supported on firm/dense soils or compacted structural fill. Any loose soil encountered at the slab subgrade should be either recompacted to a dense condition or over-excavated to expose dense native soils. Over-excavation should be replaced with compacted structural fill.

Interior concrete slab-on-grade floors should be underlain by a capillary break consisting of at least of 4 inches of pea gravel or compacted 5/8-inch, clean crushed rock (less than 3 percent fines). The capillary break material should also have no more than 10 percent passing the No. 4 sieve and less than 5 percent by weight of the material passing the U.S. Standard No. 100 sieve. The capillary break should be placed on the subgrade that has been compacted to a dense and unyielding condition. A 10-mil polyethylene vapor barrier should also be placed directly below the slab. We also recommend that construction joints be incorporated into the floor slab to control cracking.

5.5 Temporary Excavation and Shoring

As previously discussed, conceptual design drawings or site plans are not currently available. However, we anticipate that excavations at least 4 feet deep will be needed for foundation construction. Alternatively, if daylight basements are included in the design, temporary excavations as deep as 10 feet will be needed for basement foundation construction. The foundation excavation is anticipated to encounter loose to medium dense fill overlying medium dense to dense glacial till. Where space is available, an unsupported slope cut will be the most cost-effective means of temporary excavation support.

If a 1H:1V (horizontal:vertical) projection from the bottom of the excavation daylights outside the property line, temporary shoring will be needed to support the excavation, unless an easement can be acquired from the neighboring property owner. If needed, it is our opinion that a cantilevered soldier pile wall would be an appropriate temporary shoring system for this project.

Temporary excavations greater than 4 feet deep must be properly sloped or shored. All temporary excavations should be performed in accordance with Part N of WAC (Washington Administrative Code) 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring.

5.5.1 Temporary Open Cuts

For planning purposes, the temporary unsupported excavation may be sloped as steep as 1H:1V (Horizontal: Vertical). The cut slopes should be re-evaluated in the field during construction based on actual observed soil conditions, and may need to be flattened in the wet seasons and should be covered with plastic sheets. We also recommend that heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within a distance equal to 1/3 the slope height from the top of any excavation.

5.5.2 Temporary Shoring – Concrete Block Wall Considerations

Based on the loose existing fill encountered in the test borings, we do not anticipate the soils would have sufficient stand-up time to allow for installation of a temporary concrete block (i.e. Ultra-Block or ecology block) gravity shoring wall. Therefore, it is our opinion that a temporary concrete block shoring wall is not well suited for this project.

5.5.3 Temporary Shoring – Cantilevered Soldier Pile Wall

Driven Soldier Piles - Because very dense glacial till was encountered in our test borings, it is our opinion that conventional drilled-in-place soldier piles should be used. Driven soldier piles may not be able to achieve the required penetrations.

Drilled Soldier Piles - A cantilevered soldier pile wall consists of vertical steel beams, typically spaced from 6 to 8 feet apart along the proposed wall alignment, spanned by timber lagging to support the adjacent soil. Prior to the start of excavation, the steel beams are installed into holes drilled to a design depth and then backfilled with structural concrete and/or lean mix concrete per the shoring design. Because of the potential for loose soils, it may be necessary to use temporary casings to maintain the stability of the drilled hole. As the excavation proceeds downward and the steel piles are subsequently exposed, timber lagging is installed between the piles and any voids backfilled with free-draining material or controlled density fill (CDF).

The soldier pile wall system should be designed to provide adequate protection for the workers, adjacent structures, utilities, and other facilities. Excavations should be performed in accordance with the current requirements of the Washington Industrial Safety and Health Act (WISHA). Construction should proceed as rapidly as feasible, to limit the time temporary excavations are open/exposed.

***Design Lateral Pressures* –** For a cantilevered soldier pile wall, the earth pressures depicted on Figure 3 should be used for design. The lateral earth pressures shown on Figure 3 should be increased for any surcharge loads resulting from traffic, construction equipment, building loads or backslopes if they are located within the height dimension of the wall. The passive pressure shown in Figure 3 assumes level ground at the base of the wall. Above the bottom of the excavation, or base of wall, the recommended active earth and surcharge pressures should be applied over the full width of pile spacing. Below the bottom of the excavation or base of wall, the active and surcharge pressures should be applied over one pile diameter or width, and the passive resistance should be applied over two times the pile diameter or width.

If the soldier pile wall will be permanent, such as for site retaining walls, we recommended a uniform seismic pressure of 10H (psf) should be included in the pile design. For the seismic condition, the recommended passive pressure may be increased by one third.

***Lagging* -** Lagging design recommendations for the anticipated conditions are presented on Figure 3. Lagging for temporary walls typically consists of timber boards. For permanent walls, the lagging may consist of cast-in-place concrete, pre-cast concrete panels, steel sheets, or treated timber boards with the expectation that they will need to be replaced after the timber deteriorates.

Performance – Soldier pile walls designed in accordance with the recommendations discussed above may be expected to deflect laterally about 1 inch or less.

Drainage – For temporary walls with timber lagging, no additional drainage provisions are required, as the gaps in the timber boards will allow water to seep through.

Construction Considerations – Due to the loose fill soils, caving of the drilled holes could occur, and the contractor should be prepared to use temporary casing to maintain hole stability during soldier pile installations. If more than 6 inches of water accumulates at the bottom of the drilled hole prior to concrete placement, tremie methods of concrete placement will be required.

Survey Monitoring – Ground movements will occur resulting from excavation activities. As a result, conditions of the adjacent structures and ground surface elevations should be documented prior to commencing earthwork to provide baseline data. As a minimum, we recommend that the existing adjacent residences be monitored during construction. This may include monitoring any existing cracks, and photo-documenting conditions. Optical survey points should also be established on the corners of the existing residences adjacent to the excavation, as well as on the tops of every other soldier pile. Both vertical and horizontal deformations should be measured at least weekly during the excavation process. The monitoring frequency may be reduced based on the results of the monitoring. We recommend that the monitoring be performed by a licensed surveyor, and the results submitted to PanGEO for review. The results of the monitoring will allow the design team to confirm design parameters, and for the contractor to make adjustments if necessary.

5.6 Permanent Drainage And Infiltration Considerations

Permanent control of surface water should be incorporated in the final grading design. Adequate surface gradients and drainage systems should be incorporated into the design such that surface runoff is directed away from structures and walls, adequately collected, and discharged to a suitable outlet. Under no circumstances should collected surface water or downspout drains be allowed to discharge behind retaining walls. Furthermore, roof downspouts should be tightlined to a suitable outlet, and not discharged into the wall or perimeter footing drain system.

Based on the observed soil conditions from our field explorations, it is our opinion that on-site infiltration could be feasible for this project. If infiltration will be utilized for this project, a field infiltration test will need to be performed to determine a design infiltration rate to size the infiltration facility. PanGEO can provide a proposal to perform an infiltration assessment at your request.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

Site preparation for the proposed project includes removing the existing structure, stripping and clearing of surface vegetation, and excavations to the design subgrade. All debris from demolition should be removed from the site prior to the start of excavations or grading. All stripped surface materials should be properly disposed off-site or be "wasted" on site in non-structural landscaping areas.

Following site clearing and excavations, the adequacy of the subgrade where structural fill, foundations, slabs, or pavements are to be placed should be verified by a representative of PanGEO. The subgrade soil in the improvement areas, if recompacted and still yielding, should also be over-excavated and replaced with compacted structural fill or CDF/lean-mix concrete.

6.2 Material Reuse

In the context of this report, structural fill is defined as compacted fill placed under footings, concrete stairs and landings, and slabs, or other load-bearing areas. The contractor should be aware that the site soils are moisture sensitive and may be difficult to compact to the requirements of structural fill. As a result, the excavated site materials may not be suitable for use as structural backfill, particularly during periods of wet weather. If import structural fill is needed, it should consist of a well-graded granular material, such as City of Seattle Type or 17 or approved equivalent.

Well-graded recycled concrete may also be considered as a source of structural fill. Use of recycled concrete as structural fill should be approved by the geotechnical engineer. The on-site soil can be used as general fill in the non-structural and landscaping areas. If use of the on-site soil is planned, the excavated soil should be stockpiled and protected with plastic sheeting to prevent softening from rainfall in the wet season.

6.3 Structural Fill Placement and Compaction

Structural fill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557.

Depending on the type of compaction equipment used and depending on the type of fill material, it may be necessary to decrease the thickness of each lift in order to achieve adequate compaction. PanGEO can provide additional recommendations regarding structural fill and compaction during construction.

6.4 Surface Drainage and Temporary Erosion Considerations

Surface runoff can be controlled during construction by careful grading practices. Typically, this includes the construction of shallow, upgrade perimeter ditches or low earthen berms in conjunction with silt fences to collect runoff and prevent water from entering excavations or to prevent runoff from the construction area leaving the immediate work site. Temporary erosion control may require the use of hay bales on the downhill side of the project to prevent water from leaving the site and potential storm water detention to trap sand and silt before the water is discharged to a suitable outlet. All collected water should be directed under control to a positive and permanent discharge system. Potential issues associated with erosion around the development may be reduced by establishing vegetation within disturbed areas immediately following grading operations.

6.5 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.
- Geotextile silt fences should be installed at strategic locations around the site to control erosion and the movement of soil.

- Excavation slopes and soils stockpiled on site should be covered with plastic sheeting.

7.0 ADDITIONAL SERVICES

To confirm that our recommendations are properly incorporated into the design and construction of the proposed residence(s), PanGEO should be retained to conduct a review of the final project plans and specifications, and to monitor the construction of geotechnical elements. The City of Mercer Island, as part of the permitting process, may also require geotechnical construction inspection services. PanGEO can provide you a cost estimate for construction monitoring services at a later date.

8.0 CLOSURE

We have prepared this report for Mr. Chinmey Dubey 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 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.

Sincerely,

4/27/21

Shawn M. Harrington, G.I.T.
Staff Geologist

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

9.0 REFERENCES

City of Seattle, 2020, *Standard Specifications for Road, Bridges, and Municipal Construction*.

International Code Council, 2018, *International Building Code (IBC), 2018.*

Troost, K.G., and Wisher, A. P, 2006. *Geologic Map of Mercer Island, Washington, scale 1:24,000*.

Washington Administration Code (WAC), 2019, *Part N – Excavation, Trenching, and Shoring.*

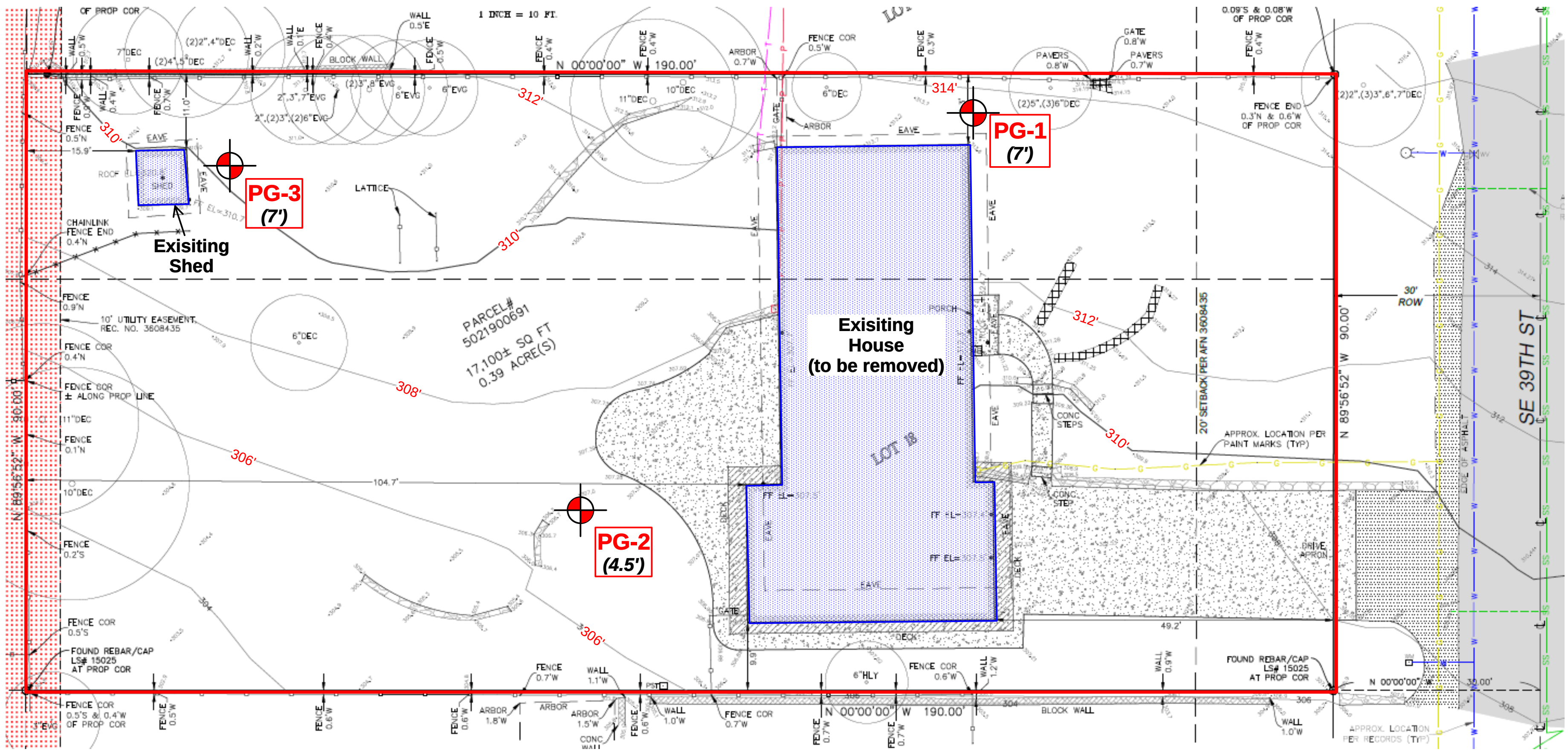
WSDOT, 2020, *Standard Specifications for Road, Bridge and Municipal Construction, M 41-10, Washington State Department of Transportation*

PanGEO INCORPORATED

Proposed Development
8434 SE 39th Street
Mercer Island, WA

VICINITY MAP

Project No.	Figure No.
21-145	**1**



Legend:

Property Boundary

Exisiting Structures

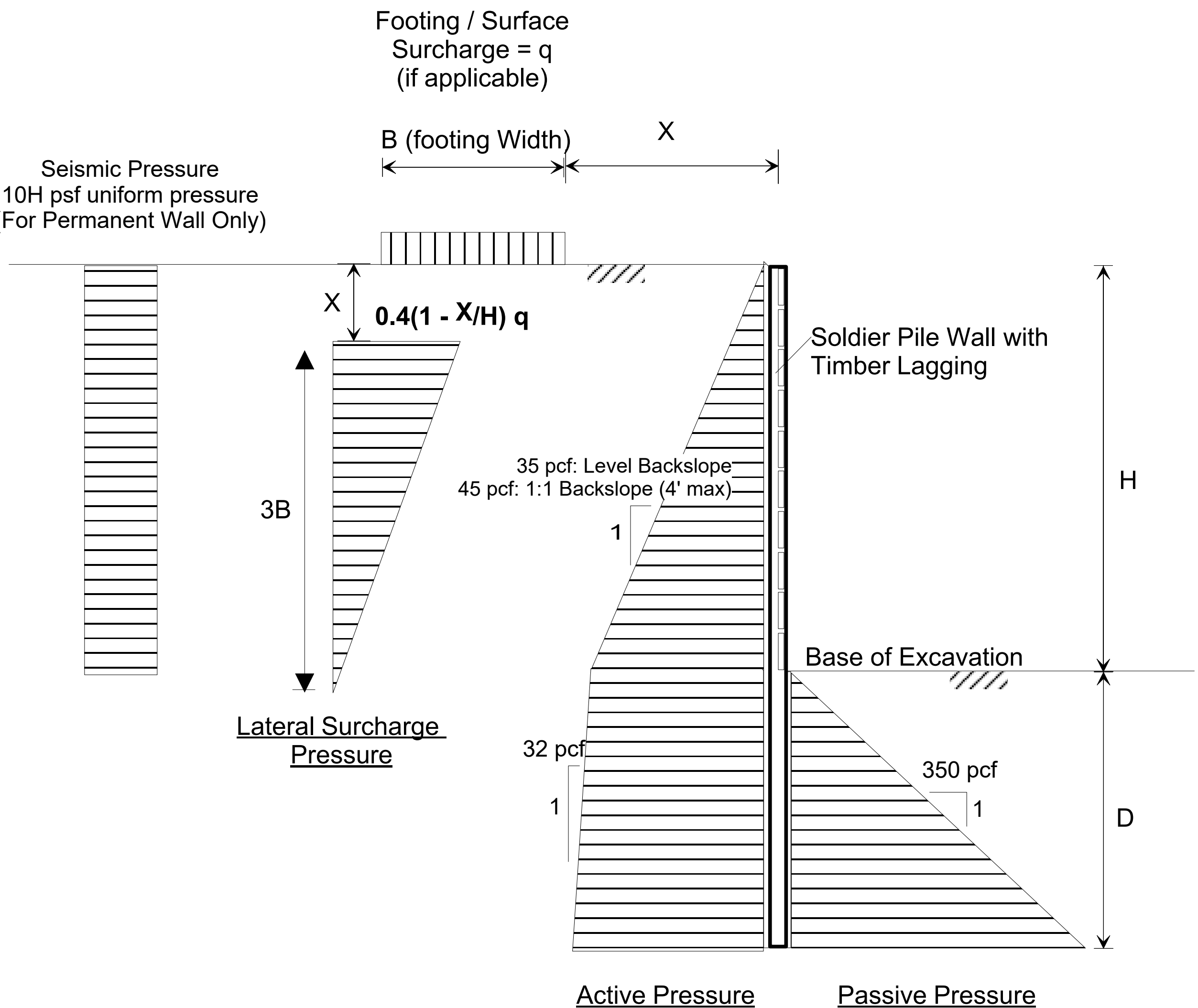
Approximate Boring Location
(Depth to Bearing Soil in Feet)

PG-1
(7')

Note: Base map modified from topographic and boundary survey by Terrane, dated March 24, 2021. Elevations based on NAVD88.

Approx. Scale
1" = 20'

PanGEO INCORPORATED	**Proposed Development** **8434 SE 39th Street** **Mercer Island, WA**	**SITE AND EXPLORATION PLAN**	
		Project No. **21-145**	Figure No. **2**



Notes:
1. Embedment (D) should be determined by summation of moments at the bottom of the soldier piles. Minimum embedment should be at least 10 feet.
2. A factor of safety of 1.5 has been applied to the recommended passive earth pressure value. No factor of safety has been applied to the recommended active earth pressure values.
3. Spacers (1/8 inch) should be provided between timber lagging to promote drainage.
4. Active and surcharge pressures should be applied over the full width of the pile spacing above the base of the excavation, and over one pile diameter below the base of the excavation.
5. Passive pressure should be applied to two times the diameter of the soldier piles.
6. For lagging design, use 50% of the recommended active earth pressure.
7. Refer to report text for additional discussions.

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Proposed Development
8434 SE 39th Street
Mercer Island, WA

DESIGN LATERAL PRESSURES
CANTILEVERED SOLDIER PILE WALL

Project No.	Figure No.
21-145	**3**

21-145 Fig 3 SP Pressures.grf 4/29/21 (12:33:58)

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	**Fissured:**	Breaks along defined planes
Laminated:	Layers of soil typically 0.05 to 1mm thick, max. 1 cm	**Slickensided:**	Fracture planes that are polished or glossy
Lens:	Layer of soil that pinches out laterally	**Blocky:**	Angular soil lumps that resist breakdown
Interlayered:	Alternating layers of differing soil material	**Disrupted:**	Soil that is broken and mixed
Pocket:	Erratic, discontinuous deposit of limited extent	**Scattered:**	Less than one per foot
Homogeneous:	Soil with uniform color and composition throughout	**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 13-104_LOGS.GPJ PANGEO.GDT 6/18/13

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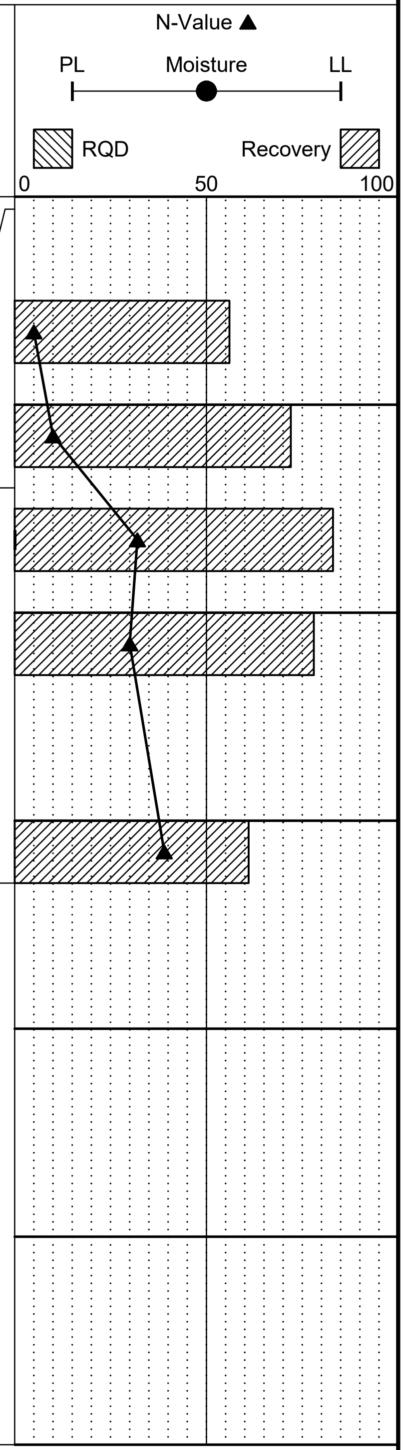
Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project:	Proposed Residences		Surface Elevation:	~314 ft
Job Number:	21-145		Top of Casing Elev.:	n/a
Location:	8434 SE 39th St, Mercer Island, WA		Drilling Method:	HSA
Coordinates:	Northing: 47.57599, Easting: -122.22522		Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Grass overlying approximately 3 inches of topsoil (dark brown silty sand with organics).
						FILL [Hf] Loose to medium dense, brown, silty fine SAND with gravel, trace organics; moist, disturbed.
	S-1	SPT	4 3 2			
5	S-2	SPT	4 5 5			-- Minor iron-oxide staining.
						VASHON TILL [Qvt]
	S-3	SPT	13 16 16	GS		Dense, gray-brown, well-graded gravelly SAND with some silt; moist (SW-SM).
10	S-4	SPT	10 15 15			*Hard drilling in gravel/cobbles from 10 to 15 feet below grade.*
15	S-5	SPT	10 16 23			-- Decrease in gravel content to trace; massive texture.
						Boring terminated about 16.5 feet below grade. Groundwater was not encountered during drilling.
20						
25						
30						



Completion Depth:	16.5ft
Date Borehole Started:	3/31/21
Date Borehole Completed:	3/31/21
Logged By:	S. Harrington
Drilling Company:	Geologic Drill Partners

Remarks: Borings drilled using Bobcat-mounted mini-track drill rig. Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Coordinates are approximate and based on their relative location to known site features. Surface elevation estimated from topographic survey by Terrane, dated March 24, 2021. Elevations based on NAVD88.

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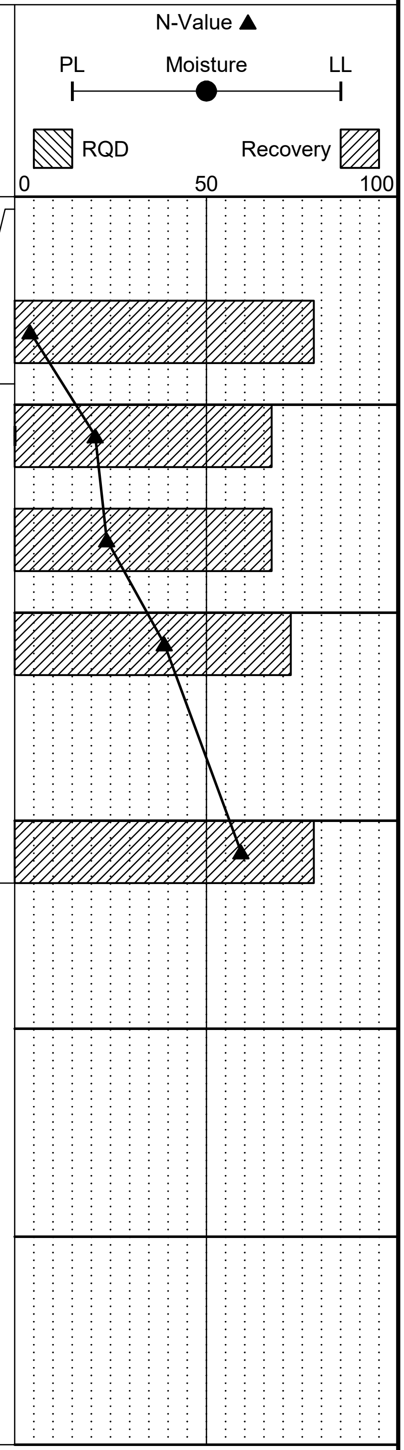
LOG OF TEST BORING PG-1

Figure A-2

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

Project:	Proposed Residences	Surface Elevation:	~306 ft
Job Number:	21-145	Top of Casing Elev.:	n/a
Location:	8434 SE 39th St, Mercer Island, WA	Drilling Method:	HSA
Coordinates:	Northing: 47.57613, Easting: -122.22541	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Grass overlying approximately 4 inches of topsoil (dark brown silty sand with organics).
						FILL [Hf] Loose, brown, silty fine SAND, trace gravel, trace organics; moist, minor iron-oxide staining, disturbed.
	S-1	X	2 1 3			
5						**VASHON TILL [Qvt]** Medium dense, gray-brown, silty gravelly SAND, occasional cobble; moist, sand medium to coarse, minor iron-oxide staining (SM).
	S-2	X	7 9 12	GS		
	S-3	X	9 12 12			-- Increase in gravel content. *Hard drilling in gravel/cobbles from 7.5 to 15 feet below grade.*
10	S-4	X	19 24 15			-- Becomes dense; slight increase in moisture content around 11 feet below grade.
15	S-5	X	16 33 26			-- Becomes very dense.
						Boring terminated about 16.5 feet below grade. Groundwater was not encountered during drilling.
20						
25						
30						



Completion Depth:	16.5ft
Date Borehole Started:	3/31/21
Date Borehole Completed:	3/31/21
Logged By:	S. Harrington
Drilling Company:	Geologic Drill Partners

Remarks: Borings drilled using Bobcat-mounted mini-track drill rig. Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Coordinates are approximate and based on their relative location to known site features. Surface elevation estimated from topographic survey by Terrane, dated March 24, 2021. Elevations based on NAVD88.

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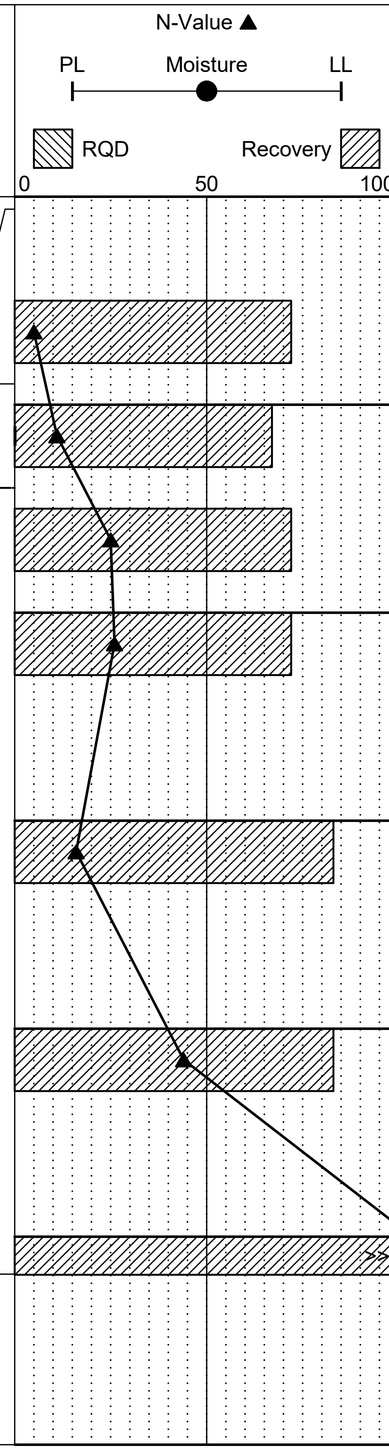
LOG OF TEST BORING PG-2

Figure A-3

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

Project:	Proposed Residences	Surface Elevation:	~311 ft
Job Number:	21-145	Top of Casing Elev.:	n/a
Location:	8434 SE 39th St, Mercer Island, WA	Drilling Method:	HSA
Coordinates:	Northing: 47.57629, Easting: -122.22525	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Grass overlying approximately 4 inches of topsoil (dark brown silty sand with organics).
						FILL [Hf] Loose, gray-brown, silty fine SAND, scattered gravel, trace organics; moist, disturbed.
	S-1	SPT	1 2 3			
5	S-2	SPT	4 5 6	GS		**WEATHERED VASHON TILL** Medium dense, gray-brown, silty SAND, trace gravel, trace organics; moist, occasional laminated silt lenses (SM).
	S-3	SPT	7 12 13			**VASHON TILL [Qvt]** Medium dense, brown, silty gravelly SAND; moist, occasional cobble.
10	S-4	SPT	8 13 13			
15	S-5	SPT	5 8 8			-- Occasional gray silt pockets.
20	S-6	SPT	15 23 21			-- Becomes dense; increase in gravel content. *Hard drilling in gravel/cobbles from 20 to 25 feet below grade.*
25	S-7	SPT	39 50/5			-- Becomes very dense; minor iron-oxide staining.
						Boring terminated about 25.9 feet below grade. Groundwater was not encountered during drilling.
30						



Completion Depth:	25.9ft
Date Borehole Started:	3/31/21
Date Borehole Completed:	3/31/21
Logged By:	S. Harrington
Drilling Company:	Geologic Drill Partners

Remarks: Borings drilled using Bobcat-mounted mini-track drill rig. Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Coordinates are approximate and based on their relative location to known site features. Surface elevation estimated from topographic survey by Terrane, dated March 24, 2021. Elevations based on NAVD88.

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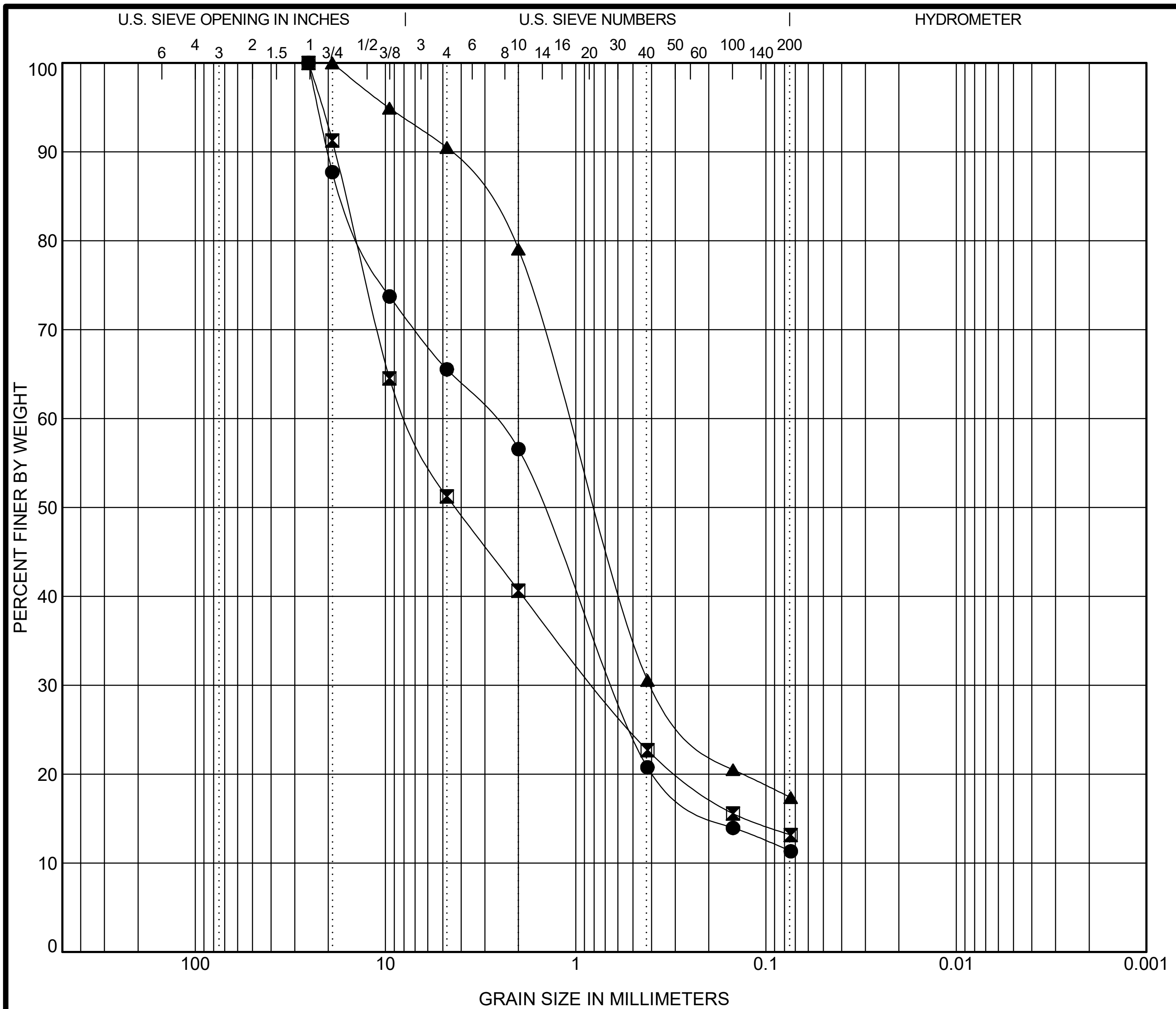
LOG OF TEST BORING PG-3

Figure A-4

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

APPENDIX B

LABORATORY TEST RESULTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**PG-1**	**@ 7.5 ft.**	**WELL-GRADED SAND with SILT and GRAVEL(SW-SM)**					
⊠	**PG-2**	**@ 5.0 ft.**	**Silty gravelly SAND (SM)**					
▲	**PG-3**	**@ 5.0 ft.**	**Silty SAND with trace gravel (SM)**					

	Specimen Identification		D100	D90	D60	D10	%Gravel	%Sand	%Silt	%Clay
●	**PG-1**	**7.5**	**25.4**	**20.095**	**2.786**		**34.5**	**54.1**	**11.4**	
⊠	**PG-2**	**5.0**	**25.4**	**18.433**	**7.523**		**48.8**	**38.0**	**13.2**	
▲	**PG-3**	**5.0**	**19.05**	**4.586**	**1.084**		**9.5**	**73.0**	**17.4**	

GRAIN SIZE DISTRIBUTION

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Project: Proposed Residences
Job Number: 21-145
Location: 8434 SE 39th St, Mercer Island, WA

Figure B-1