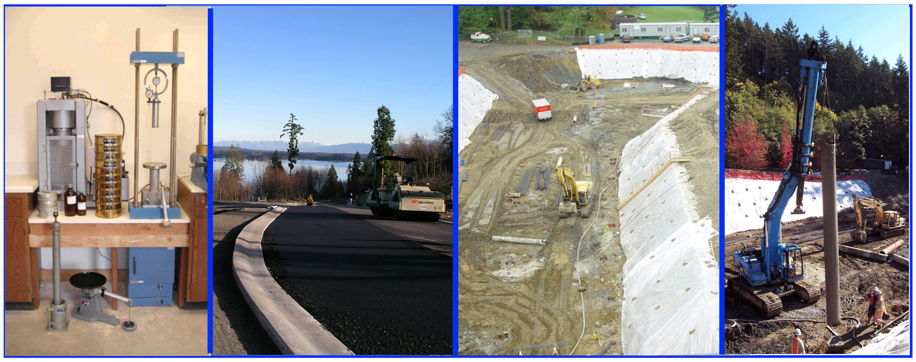
MERIT ENGINEERING INC.

GEOTECHNICAL ENGINEERING INVESTIGATION AND CRITICAL AREA STUDY

Proposed Residential Development
3804 E Mercer Way
Mercer Island, Washington 98040
Parcel#: 2107000100



Prepared For:
Chunling Ou

3804 E Mercer Way
Mercer Island, Washington 98040

December 12, 2024
Project No. 2DK0233995

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December 12, 2024
Project No. 2DK0233995

Chunling Ou
chunling.office@gmail.com

Re: Geotechnical Engineering Investigation
3804 E Mercer Way
Mercer Island, WA 98040
Parcel#: 2107000100

Dear Chunling:

At your request, we have conducted a geotechnical engineering investigation at the above referenced project site. We did the infiltration feasibility study according to our previous proposal P2DK0238791. According to the City of Mercer Island GIS Map, the subject site has critical areas, including erosion, potential landslide, and seismic hazard. We understand that the planning comments 1 (a. to g.) from Review Letter 1 (CAO24-013) issued by the City of Mercer Island need to be addressed by geotechnical engineer. The following geotechnical engineering report represents the results of our visual site reconnaissance, boring observations, engineering analysis, and derived conclusions on the critical area evaluation of proposed residential building.

Thank you for this opportunity to work with you on this project. Please contact us if you have any questions about this report.

Sincerely,

Austin X. Huang, Ph.D., P.E., L.G., D.GE., F.ASCE
Principal

F.ASCE: Fellow - American Society of Civil Engineering
D.GE - Diplomate - Academy of GeoProfessionals

D.GEs provide successful projects that benefit their clients.
The D.GE certification recognizes geotechnical engineers who possess specialty education, extensive experience, integrity, and good judgment.

GEOTECHNICAL ENGINEERING REPORT AND CRITICAL AREA STUDY

Proposed Single Family House
3804 E Mercer Way
Mercer Island, Washington 98040

Prepared for:

Chunling Ou
3804 E Mercer Way
Mercer Island, Washington 98040

by

AUSTIN X HUANG
28545
December 12, 2024

Austin X. Huang, Ph.D., P.E., L.G., G.DE, F.ASCE
Principal

December 12, 2024
Project No. 2DK0233995

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1. INTRODUCTION

At request of Chunling Ou, Merit Engineering, Inc. has conducted a geotechnical engineering investigation for the proposed development of the site, located at 3804 E Mercer Way, in Mercer Island, Washington 98040 (Parcel# 2107000100). The project area and vicinity is shown in Figure 1 and the site plan with test locations in Figure 2 in the Appendix.

We did the infiltration feasibility study according to our previous proposal P2DK0238791. Based on the architectural plan dated December 11, 2024, provided by MJZ Design, we understand that the site is currently occupied by a single-family house at the center, with a carport to the west and a grassy backyard to the east. The proposed project is to demolish the existing house and build a new house. The new house is at approximately same location with a larger footprint and does not anticipate reusing any of the existing foundation. The proposed scope of work also includes grading, landscaping, and constructing driveways to the east and west of the new house as detailed in the landscape plan dated December 11, 2024 prepared by Lotus Landscape Design.

According to the City of Mercer Island GIS Map, the subject site has critical areas, including erosion, potential landslide, and seismic hazard. We also understand that the planning comments 1 (a. to g.) from Review Letter 1 (CAO24-013) issued by the City of Mercer Island need to be addressed by geotechnical engineer.

Therefore, the objective of this study specifically was to investigate surface, subsurface at the site, and conduct a hazard analysis, derive conclusions, and provide recommendations for site preparation, design, construction and geologic hazard mitigation of the proposed house and associated landscape improvements. The report will, in particular, address critical area concerns of geologically hazardous area, to comply with City of Mercer Island Land

Development Code 19.07.060 - Critical area maps and inventories, 19.07.090 - Critical area reviews, 19.07.100 - Mitigation sequencing, 19.07.110 - Critical area study, and 19.07.160 - Geologically hazardous.

2. PROJECT DESCRIPTION

The project site is a rectangular shaped parcel of land with an area of approximately 14,342sf shown on the King County Assessor. The project site is located at 3804 E Mercer Way, Mercer Island, Washington 98040 with a parcel number of 2107000100 as shown on the King County GIS Map. The site is at east of E Mercer Way with a shared private road leading to the subject site. The proposed project is to demolish the existing house and build a new house. The new house is at approximately same location with larger footprint. Regrading and Landscaping work is also proposed at site. According to the landscape plan dated December 11, 2024 prepared by Lotus Landscape Design, the proposed landscaping improvements include:

1. Remove the existing carport and surrounding retaining walls to provide an improved entry.
2. Construct a semicircular driveway for guests parking in the front yard landscape area, along with an entry walkway to the front door.
3. In the backyard, a concrete retaining wall, up to 4 feet high, will be constructed to create a gentle slope or a flat area.
4. Construct a patio area in the backyard, which will also function as an access path leading from the private driveway to the backyard. Plant new trees and create new lawn areas cross the site.

3. SCOPE

Based on all the above information and understanding of the project, we conducted a site exploration using Standard Penetration Test (SPT[1]) with scope of work in compliance with our proposal No. P2FG0335878 dated October 9, 2024, in particular includes:

- Conducting a site reconnaissance of the property and adjacent area;
- Reviewing the available soil reports for nearby properties;
- Conducting two (2) SPT borings to maximum depth of 10 feet, where penetration refusal was encountered.
- Logging soil and ground water conditions;
- Performing engineering analysis;
- Preparing a geotechnical engineering report addressing the critical areas concern of erosion, potential landslides and seismic hazards with recommendations including:
    (1) surface conditions
    (2) subsurface soil conditions
    (3) groundwater conditions, and
    (4) geological critical areas and buffers

Recommendations for:

(5) foundation design parameters
(6) structural fill and compaction criteria
(7) foundation retaining wall design parameters
(8) slab-on-grade floor
(9) drainage; and
(10) site grading.

4. SITE INVESTIGATION

4.1 Surface Conditions

Site reconnaissance was conducted by Alex Yu, a project engineer and representative of Merit Engineering, Inc., on November 4, 2024, during our field tests. A survey completed by

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[1] SPT consists of driving a split-barrel sampler of 1.5″ ID (Inside Diameter) and 2″ OD (Outside Diameter) 18″ into ground using a 140 pounds hammer with 30″ of free fall. The number of blows for last one foot of penetration is obtained as blow count, N which is correlated with the strength properties of soil.

Site Surveying, Inc. was used in this study to construct site plans showing property lines, major features, and test boring and test pit locations (Figures 2). The City of Mercer Island, King county online GIS map program was used to reference general topographic features at the site. Test pits were excavated on November 26, 2022 in previously infiltration feasibility report and SPT borings were conducted on November 4, 2024. We also observed surface topography, surface soils, vegetation, and surface water conditions at the subject site.

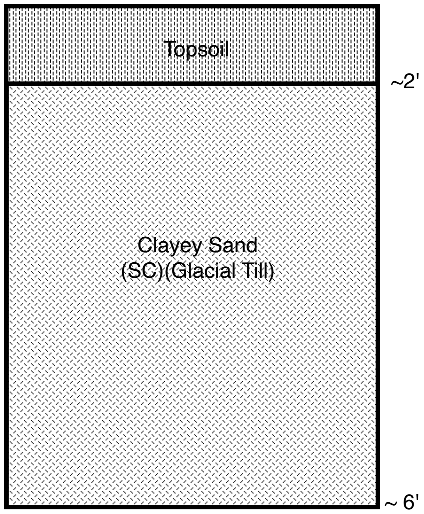
This subject site is located at east of E Mercer Way overlooking east to Lake Washington. The site is currently occupied by a single-family house with a carport that connects to a shared private road leading to E Mercer Way to the west and grassy yard to the east. The topography of the property has a gentle slope (14.3%) toward the eastern property boundary. The downward slope continues to the east of the property and ultimately reaches Lake Washington. During our site visit, two cherry laurels were observed to the northwest of the existing house along the north property boundary, with diameters of approximately 24 inches and 11 inches, respectively. A maple tree with a diameter of approximately 19 inches was also observed near the east property boundary on the adjacent site. The trees are vertically straight and do not show signs of slope movement. The landscape includes grass land, retaining walls and concrete steps at west, as well as a patio at east of site.

4.2 Subsurface Conditions

The site access is difficult for large machine, therefore a portable standard penetration equipment was used for testing. Surface soil and ground water conditions were investigated by conducting two (2) SPT borings at site to maximum 10´ depth on November 4, 2024. Test locations are shown on the site plan (Figure 2). SPT tests are presented in the Appendix of this report as Figures 4 and 5. Descriptions of soil symbols and classifications used in this report are also presented in the Appendix (Figure 3). This study also references the excavated test pits from November 26, 2022, mentioned in the previous infiltration feasibility report. The geotechnical reports from adjacent sites to the west, east and south were also reviewed. Site soils are generalized in the schematic and summarized as follows:

a. Topsoil (SM)

b. Clayey Sand (SC)(Glacial Till)



a. Topsoil (SM)

A layer of topsoil which varies in thickness from 0” - 2´ generally blankets the surface of site. The soil is black, loose with organic grass roots.

b. Clayey Sand (SC)(Glacial Till)

Underling the topsoil, beginning at a depth of ~2´ depth to a maximum depth of ~10´ where penetration refusal was encountered, was a layer of clayey sand. The soil is light brown to gray with some cobbles, dense to very dense, and dry.

4.3 Geologic Background

The Lake Washington basin and Puget Sound areas were overidden by Vashon glacier around 17,600 years Cal B.P. At its maximum extent, the ice was over 3,000 feet thick in the seattle area and extended from the foothills of the Olympics to the foothills of the Cascade Mountains and from Brithsh Columbia, Canada, to south of Olympia, Washington (Booth and others, 2004). During glacial advance, sub-glacial melt water carved the Lake Washington basin and all the troughs of Puget Sound, including the Duwamish, Green, Puyallup, and Sammamish river valleys. Sub-glacially, these troughs were connected to Puget Sound, and when the ice receded, the troughs were still connected via water.

The 1:100,000 geologic map from Washington State Department of Natural Resources indicates the area of the project site is mapped as Pleistocene continental glacial till (Qgt) - unsorted, unstratified, highly compacted mixture of clay, silt, sand, gravel, and boulders deposited by glacial ice; may contain interbedded stratified sand, silt, and gravel. The soils as also indicated in the NCRS soil report for this property are primarily AgC, Alderwood gravelly sandy loam, 8 to 15 percent slopes. This is consistent with our exploration.

4.4 Surface and Ground Water Conditions

No groundwater seepage was observed in test borings on November 4, 2024. No surface water was observed on site during our exploration on November 4, 2024. Lake Washington is located approximately 180 feet to the east of the subject property. According to the geotechnical reports from adjacent sites to the west, east and south, perched groundwater was encountered at various elevations and times of the year. Specifically, at Gibson short-plat project, perched ground water was encountered at approximately EL 82´ (100’ – 18’) in borings B-1 in late May 2005, and at EL 40´ (60´ – 20´) in boring B-101 in March 2014. No groundwater was identified in Lum property to the West, although borings did not exceed 10.5 feet. The borings done on Ken’s property to the East were very shallow. Light perched groundwater seepage was encountered in April 1989 at EL 26´ at test pit 1 on south side of site, and at EL 18´ at TP-2 at SE corner. This is consistent with our findings during site exploration. If groundwater were to be encountered within this site, it would be considered to be “perched” groundwater. Perched water occurs when surface water infiltrates through less dense, more permeable soils and accumulates on top of underlying, less permeable soils.

The designers and contractors should be aware that groundwater levels can fluctuate depending on the season, amount of rainfall, surface water runoff, and other factors. Generally, the water level is higher and seepage rates are greater in the wetter, winter months (typically October through May).

5. GEOLOGIC HAZARDS

5.1 Geologic Hazard Designation

Geologic hazard areas are designated by the City of Mercer Land Development Code (LDC19.07.160A) that geologically hazardous areas are lands that are susceptible to erosion, landslides, seismic events, or other factors as identified by Washington Administrative Code (WAC 365-190-120). We researched available publications for geologic hazard areas on or in the vicinity of the site.

5.2 Landslide Hazards (LDC 19.16.010)

The LDC 19.16.010 defines Landslide Hazard Areas based on a combination of geologic, topographic, and hydrologic factors. They include any areas susceptible to landslide because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors, and include, at a minimum, the following:

1. Areas of historic failures;
2. Areas with all three of the following characteristics:
    a. Slopes steeper than 15 percent; and
    b. Hillsides intersecting geologic contacts with a relatively permeable sediment
    c. overlying a relatively impermeable sediment or bedrock; and

Springs or ground water seepage;

3. Areas that have shown evidence of past movement or that are underlain or covered by mass wastage debris from past movements;
4. Areas potentially unstable because of rapid stream incision and stream bank erosion; or
5. Steep slope. Any slope of 40 percent or greater calculated by measuring the vertical rise over any 30-foot horizontal run.

The subject site was depicted as potential landslide hazards area on City of Mercer Island GIS Map. The site dose not contain 40 percent or steeper slope. The site consists of slopes with gradients of 14.3 percent, which are less than 15 percent. We observed no surficial evidence of recent or historic landslide activity or slope instability during our geologic reconnaissance of the site. As discussed above, the site contains a number of large deciduous trees, none of which show any signs of past or on-going slope movement. The site is not within certain mapped intersecting geologic contacts which are prone to producing springs or groundwater seepage.

We compared the each criterion of the Critical Area Ordinance with site existing conditions. None of these conditions are present at the site. Base on our investigation and engineering analysis, the site is not a Landslide Hazard Area as defined by the LDC in our opinion.

5.3 Erosion Hazard Areas (LDC 19.16.010)

The LDC 19.16.010 defines those areas greater than 15 percent slope and subject to a severe risk of erosion due to wind, rain, water, slope and other natural agents including those soil types and/or areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service as having a "severe" or "very severe" rill and inter-rill erosion hazard.

The site is within a large areas mapped by the City of Mercer Island as a potential erosion hazard area. Site specific evaluations must be made in each application to determine actual site conditions. And discoverable information of actual site conditions from site-specific review is both the most accurate and reliable information to determine whether a particular site or portion of a site falls under the City's definition of an Erosion Hazard Area. The City Code should be logically read to only resort to SCS mapping as determinative if there is some ambiguity with respect to site-specific circumstances. Such is not the case for this project as we have had the opportunity to perform a complete site evaluation. It should be noted that the proposed new single-family house is at approximately same location of existing house.

Based on 1) the soils encountered in explorations completed at the site, 2) the condition of the existing vegetation at the site, and 3) the absence of existing erosion features at the site, in our opinion the erosion potential of the site is low. Therefore, in our opinion the site does not fall within the City's definition of an Erosion Hazard Area. However, the erosion may exist during construction from disturbed soils. Therefore we have included recommendations to mitigate erosion hazards at the site later in this report.

5.4 Seismic Hazard Areas (LDC 19.16.010)

The LDC 19.16.010 defines seismic hazard areas are areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction or surface faulting.

The site and vicinity is mapped as having a very low liquefaction susceptibility to seismic shaking according to the King County Liquefaction hazard map (May, 2010). And based on our field tests, the site soils consist primarily of very dense till soil at shallow depth. See the seismic hazard discussion in section 8.8 below for more details.

6. CRITICAL AREAS EVALUATION

6.1 Slope Considerations

During this study, we considered local slope conditions in order to evaluate the critical areas identified above and assess project feasibility. From site SPT tests, test pits. reconnaissance, and our knowledge of local geology, local slope stability on the site appears to be controlled by the relationship of the cover topsoil and hard refusal soil underneath.

Slope stability against erosion and local slumping is influenced by the interaction of the natural topography, shallow soil character, groundwater, and slope of the hardpan till or glacial deposits that may act as a failure plane. Cover soil stability must also be considered in relation to slope grading and design for the proposed development.

We understand that the proposed development is to demolish the existing house and build a new house. The new house is at approximately same location with a larger footprint. The landscape improvement will be also at front and back yard of site. According to the architectural plan dated December 11, 2024, prepared by MJZ design, the proposed basement is at approximately same elevation of existing house basement. The proposed basement excavation will be approximately 10 feet deep, and it is anticipated that the cut will be retained by a temporary shoring system.

6.2 Hazard Analysis: Interpretations of Slope Stability

Our site reconnaissance did not find obvious visual evidence of current or past slope stability issues within the project area. We are not aware of any historic slope failures in the site vicinity. Due to the variable nature of the geology and topography in the area, the potential for such failures can vary widely between adjacent sites, and thus should be evaluated on a site-specific basis.

Surficial soils on the site slopes may exhibit some minor surface creep or erosional instability if disturbed during construction, and may be more at risk for ongoing erosion without stabilization measures such as replanting. Care must be taken in site design and construction to avoid loading shallow soils on slopes with fill application, walls, or other landscape features that could instigate a shallow failure of the cover soil. Recommendations on practices for slope grading and construction with erosion and drainage control are provided later in this report.

7. CONCLUSIONS AND RECOMMENDATIONS

We have conducted a study of existing site and slope conditions and critical areas assessment for the proposed single-family house at 3804 E Mercer Way, in Mercer Island, Washington 98040 (Parcel# 2107000100). to fulfill City of Mercer Island critical area requirements. The results of our site testing and reconnaissance are presented herein with accompanying discussion on slope stability concerns and interpretations.

We conclude, and it is our opinion based on the results and stated limitations of this study, that the site is suitable for the proposed single-family house if recommendations in this report are followed. The risk of damage as a result of soil instability will be minimal on the property being developed, and on adjacent properties. The use of the word "minimal" in the above statement should not be taken to imply that there is no risk, but rather that it is our opinion that the risk is low. The proposed alterations to the Critical Area should not adversely impact the surrounding Critical Areas, or increase surface water discharge, sedimentation, or erosion rates if the recommendations in this report are followed.

The following sections present a summary of this study and our recommendations for construction of single-family house to erosion control, stormwater control, and drainage control to enhance and protect the site as possible within the subject property.

We understand the project location is designated as a geologically critical area. Therefore, it is our understanding that the analyses and recommendations provided in this report are based on the assumption that our firm's level of professional services will be retained for future project design and construction phase services as needed.

7.1 Site Preparation and Grading

We recommend removing any organic topsoils and unsuitable loose and soft soils from the areas under the proposed residential structure. We anticipate that soil excavation can be accomplished with conventional equipment, although excavation into the hardpan till may be more difficult.

Any soft subgrade soils encountered during site excavation should be removed and replaced with structural fill as recommended in the Structural Fill section of this report. Based on our observations, the native silty sand subsoil may be suitable for subgrade depending on fine content, organic content, and moisture levels. Any questions regarding the suitability of soil subgrade shall be addressed Merit Engineering in the field.

Dry season construction at this site is recommended. Due to the sloping nature of the site, we recommend that care be taken to the maximum extent possible for erosion and ground control. It should be understood that significant additional costs and construction difficulty could be incurred if work proceeds in wet weather comparing with dry weather construction. Therefore, we don't recommend wet season construction.

We recommend that we observe and verify site excavation to suitable subgrade soils, test to verify import fill materials, and observe and test compaction of structural fill materials.

7.2 Construction Recommendations

7.2.1 Temporary Excavations

Temporary soil cutslopes during earthwork without control measures should generally be no steeper than 2:1 (Horizontal:Vertical) for sandy soil, and should be evaluated for general stability after shaping and periodically in construction. For temporary cutslopes that will remain exposed for any length of time, we recommend that we review conditions on site. We also recommend that we review and consult on the proposed methods of excavation prior to earthwork, and that we verify excavation to suitable cutbank conditions and geometry during construction. As local variations may exist between locations within the site, we recommend that we evaluate all cutbanks to ensure they are consistent with the conclusions in this report, and if necessary provide alternate recommendations per location.

Maximum temporary excavation depths are expected to extend to depth of 3 to 4 feet below existing grade. Temporary excavations greater than 4 feet deep should be properly sloped or shored. All temporary excavations should be performed in accordance with Part N of WAC 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring. The temporary cut slopes should be re-evaluated by a representative of Merit Engineering during construction based on actual observed soil conditions.

It is our opinion that the temporary erosion sediment control plan (TESC) dated December 11, 2024, provided by Tandem Engineering Consultant Inc., is properly designed. if it is properly developed, constructed, and maintained during construction, this erosion control plan is consistent with the design recommendations presented in this report. In addition, we recommend a designated State of Washington Certified Erosion and Sediment Control Lead (CESCL) for subject project. This person should be on-call to respond to temporary erosion and sediment control noncompliance, conduct post-storm inspections of temporary erosion, and oversee sediment control best management practices. We recommend that inspections be conducted every calendar week and within 24 hours of a storm event or discharge.

7.2.2 Dewatering

No groundwater seepage was observed in test borings on November 4, 2024. No surface water was observed on site during our exploration on November 4, 2024. However, it may be anticipated the footing excavation will encounter groundwater due to fluctuation of seasonal water table and unforeseen circumstance of heavy rainfall in wet season. The contractor should be prepared to provide a temporary dewatering system to control and remove seepage out of the excavation area. Due to the relatively fine grained nature of the soils underlying the site, we anticipate groundwater seepage in the footing excavation can be controlled by sloping the base of the excavation to drain and removing the water with sumps and pumps.

7.3 Structural Fill

Structural fill should be placed on firm, horizontal subgrade in about 10-inch thick loose lifts and compacted to at least 95% of the ASTM D-1557 maximum dry density for footings, grade slab, parking and road, and sidewalks.

We recommend import structural fill be sandy gravel or gravelly sand meeting specification - 9-03.12 (1) B, APWA/DOT 2006, that is typical in this area as base granular materials with exception that percent passing U.S. No. 200 Sieve shall not exceed 5% and all materials smaller than 4″. The specification is summarized below:

Table 1: Specification of Imported Fill Materials

Sieve Size	Percent Passing by Weight
4″ Square	100
2″ Square	75-100
U.S. No. 4	22-66
U.S. No. 200	5.0 max.
Dust Ratio $\frac{\%\ Passing\ U.S.\ No.\ 200}{\%\ Passing\ U.S.\ No.\ 40}$	⅔ max.
Sand Equivalent	30 min.

Backfill immediately behind retaining walls or adjacent to foundation stem walls should be compacted to about 90% of the ASTM D-1557 maximum dry density. Care must be taken to avoid over-compaction immediately behind walls. Backfill behind retaining walls must be free draining material.

It is important that plumbing and utility trenches be properly backfilled. Backfill in the trenches should meet the appropriate compaction criteria described above.

7.4 Foundation Design Parameters

We recommend placing foundation on native dense glacial till soils or on import structural fill installed on the native glacial till soils. Sand sub grade soils should be compacted to 95% modified proctor. If site soils are not found to be firm at a footing location and grade, we recommend excavating down to appropriately firm soils and replacing the soft/loose soil section with structural fill.

We recommend that all perimeter footings be at least 18 inches below final outside grade for frost protection. The base width of footings shall be at least 18 and 24 inches for continuous and isolated column spread footings, respectively.

Under condition of satisfying the above recommended footing dimensions, a soil bearing pressure of 2,500 psf (*pounds per square foot*) is recommended. Bearing pressure may be increased by $^1/_3$ for transient wind or seismic loads.

With the above recommended soil bearing capacity, the anticipated load on the footings, and the soil conditions from the tests, we estimate that the total potential settlement of the foundations should be less than 1 inch. While most settlement will occur in the short term as loads are applied, some settlement may occur over a long period of time after construction.

We recommend proof-rolling building pads before placement of footings with a loaded dump truck to reveal soft or yielding surficial soils. Any soft subgrade soils encountered during site excavation or exposed during proof-rolling should be re-compacted.

We also recommend that we observe and verify site excavation to suitable soil stratum, a proof roll test to verify imported fill materials, and observe and test compaction of structural fill materials.

7.5 Foundation and Site Drainage

A perimeter footing drainage system should consist of at least 6-inch diameter, perforated, rigid pipe. Pipes should be placed along the exterior base of the foundation perimeter and tightlined to a storm drain system or natural drain course. Pipe should be bedded on 2 inches, and backfilled with a minimum of 12-inches, of pea gravel.

A site gravity drain at upslope of the site is recommended to divert stormwater away from the house foundations.

Under-slab cross-drains may be helpful to maintain a dry slab floor to facilitate drainage. A cross-drain system should be overlain by drain rock beneath the slab. From our experience buildings with basement often has water problem in just matter of time. A sump pump may need to be designed to collect and divert the water.

Roof downspouts should be tightlined to a storm drain system separately from footing drains.

Based on our infiltration feasibility study dated November 26, 2022, the subject site is not favorable for onsite stormwater infiltration. Project stormwater runoff will need to be directed to a controlled detention/release stormwater facility or tight-line to municipal stormwater system.

We recommend that we be retained to consult and review on the drainage installation work.

7.6 Slab-On-Grade Floor

A slab-on-grade floor may be supported on building pads that are prepared with firm native subgrade soils, or import structure fill compacted over firm native soils. At least 4-inches of drain rock of ¾″ maximum size should be placed between the slab and slab subgrade.

A vapor barrier visquine should be placed between the slab and capillary break material. An additional 1 to 2 inches of sand may be placed on top of the vapor barrier if desired to aid in concrete curing. In addition, use of a commercial concrete slab sealant for moisture protection may prove to be very helpful.

Floor slabs reinforced with 6 x 6 wire mesh may help reduce potential crack separation and vertical offsets at cracks. Reinforcement should be set at or above the mid-depth of the slabs. To reduce cracking potential we suggest exterior patios and other flatworks contain reinforcement as recommended above for floor slabs. Any flatwork subgrades should be watered thoroughly prior to concrete placement to close soil shrinkage cracks. Flatworks should have frequent joint controls.

Additional measures to reduce potential cracking are considered warranted at critical areas where slab movement could impair use; such critical areas include any exterior patio slabs that meet the interior floor level at doorways. For such areas we recommend that recommend that the upper 12-inches of native soil be over excavated and replace with import structural materials as specified in the Structural Fill section of this report.

7.7 Lateral Earth Pressure

We recommend that we be contacted for consultation and evaluation engineered retaining walls or walls with a surcharge loads are considered in site design. We recommend placing structural fill behind subsurface and retaining wall. The horizontal thickness of the fill should be at least the height of the wall. For structural fill, as recommended in the Structural Fill section of this report with a level ground, the parameters of lateral earth pressures are listed in Table 2.

Soil	Active K_a	Passive, K_p	At Rest, K_o
Structural Fills	0.28	3.54	0.44
Equivalent Fluid Pressures*			
Structural Fills	34	425	53

*Equivalent fluid pressure is the product of lateral earth pressure coefficient and the unit weight of the soil.

The soil parameters of lateral earth pressure for the on-site soils may be much stronger than those in the above table, however, it must be evaluated to confirm on site during construction when site excavation opens up the ground for visual observation.

Design of subsurface walls should include appropriate lateral load due to adjacent surcharge. Under uniform surcharge qo, lateral load due to a uniformly distributed lateral pressure σ, should be added to active and at rest soil lateral pressure, respectively as defined in the following equations:

$$\sigma = \begin{cases} K_a q_o & \text{for active case} \\ K_o q_o & \text{for at rest case} \end{cases}$$

A coefficient of base friction of 0.55 and 0.45 may be used between concrete and structural fill and between concrete and native fine sandy soil, respectively. However, if passive pressures are used in conjunction with frictional resistance to determine lateral resistance to sliding, only 1/2 the value of passive pressure presented above should be used since larger strains are required to mobilize passive soil resistance as compared to frictional resistance.

7.8 Seismic Design Parameters

The site is located in the seismically active Puget Low lands. Deep focus earthquakes from subduction of the Juan de Fuca plate beneath the North American plate can cause amplified shaking at the ground surface due to seismic waves of different velocities interacting. Seismic waves propagate relatively slow through soft soils and considerably faster in rock. As a result, areas with softer soils underlain by rock tend to experience greater ground shaking than areas with little variation in the underlying substratum. Local building codes and design practices now consider the possible effects of soil conditions and large subduction related earthquake in the design of structures.

7.8.1 Liquefaction

Liquefaction is a phenomenon associated primarily with near surface saturated cohesionless soils under zero effective stress. Effective stress equals the confining pressure of the soil minus pore water pressure. When saturated cohesionless soils undergo cyclic seismic loading, the induced excessive pore pressure cannot dissipate and thus grows larger. When the pore pressure becomes equal to the confining pressure from the overburden load, the effective stress of the soil becomes zero and the soil lost its strength or stiffness and becomes liquefied. Foundation settlement and lateral movement could damage structures supported by liquefiable soils and sites with conditions favorable for liquefaction are designated as Site Class F. Site classes are a simplified method for describing the amplification of ground shaking during a seismic event due to effects of underlying soil conditions and are defined by a unique range of average shear wave velocities in the upper 100´ of the site soil column.

The site and vicinity is mapped as having very low liquefaction susceptibility to seismic shaking according to the King County Liquefaction hazard map (May, 2010). According to our site specific evaluations, the site soils consist primarily of very dense till soil at shallow depth. Based on these soil, it is our opinion that liquefaction potential at the site is low because soils at the site are generally very dense till.

7.8.2 Design Parameters

Using the results of our SPT (Standard Penetration Test) test holes and geologic setting as discussed in this report, we estimate the average N value, using methods provided in Section 1613 of the 2021 IBC. The results of our average N value estimated and projected for a 100´ section indicate a very dense soil N > 50. Based on the results from our subsurface exploration the soil profile at the site may be defined as Site Class D according to IBC (International Building Code) 2021, representing a stiff soil. Seismic design parameters for this site class and location, from ASCE 7 Hazard Tool with ASCE/SEI 7-22 reference document, are summarized in the following table:

Table 3: Spectral Response Acceleration (SRA)

SRA and Site Conditions	Short Period (0.2 sec)	1- Second Period
Mapped SRA	$S_S = 1.55$	$S_1 = 0.62$
SITE CLASS D		
Max. Considered Earthquake SRA	$S_{MS} = 1.68$	$S_{M1} = 1.3$
Design SRA	$S_{DS} = 1.12$	$S_{D1} = 0.87$

8.GEOLOGIC HAZARD MITIGATION

8.1 Erosion Hazard Mitigation (LDC 19.07.100)

The following general recommendations will assist in preventing high rates of erosion that may cause site slopes to become unstable during and after construction. Vegetation removal and ground disturbance on the slope should be limited to only as necessary in work areas. During construction if warranted or desired, soil containing measures such as silt fencing, hay bails, or straw waddles may be helpful in limiting erosion and the effects of earthwork activity on adjacent areas down slope. The contractor should comply with Best Management Practices (BMPs) and temporary erosion control measures as required.

The soil cutslope recommendations above are intended to reduce the overall area of ground disturbance while allowing for re-establishment of adequate slopes after construction. Care should be taken to restore disturbed or cleared areas to a naturalized state via plantings, control drainage and limit runoff onto these areas, and provide ongoing maintenance of vulnerable slope faces as needed in the long term, to minimize the potential for erosion and local soil slumps.

Construction and construction equipment should be confined to the areas of the building construction. It should be understood that the impacts of construction equipment and vegetation removal disturbs the soil and removes stabilizing rooting, causing the slope surface to be less stable. Equipment use on the slopes should be limited to light machinery.

We recommend drainage controls and appropriate outlets be applied as possible to limit the potential for slope instability due to water inundation. The on-site soil may cause areas of temporary saturation during storm events, especially around grading alterations and improvements. Features that may collect ground or surface water, should be designed with perforated pipe for water collection and drainage. Drainage pipes should be tightlined to a natural drain course or dispersed in an appropriate area below and away from slope faces.

Provided that the recommendations above are implemented, we conclude that the erosion hazard will be adequately mitigated during and after site development.

9.GENERAL CONDITIONS

The recommendations provided herein are based on our understanding of the project at this time. We expect the on-site geologic conditions to reflect our findings, however, some variations may occur. Should soil conditions be encountered that cause concern and/or are not discussed herein, Merit Engineering, Inc. should be contacted immediately to determine if additional or alternate recommendations are required.

We recommend that we verify site excavation to suitable soil stratum, verify imported fill materials, and observe and test compaction of structural fill. We recommend that we be retained to evaluate the condition of cutslopes once open, including soil condition, structures, and soil stability, and provide recommendations as needed for remediation or reinforcement of permanent cutbanks.

This report is prepared for Chunling Ou for specific application to the critical areas evaluation for the proposed development located at 3804 E Mercer Way, in Mercer Island, Washington 98040 (Parcel# 2107000100). This report has been prepared in accordance with generally accepted geotechnical/geological engineering practices in this area. No other warranty, expressed or implied, is made.

This report is an instrument of our professional service, and we (Merit Engineering, Inc.) shall retain an ownership and property interest therein. We grant Chunling Ou a license to use the instrument of our professional service for the purpose of constructing the above mentioned proposed development. We do not permit reuse or modification of this document for application to a different structure or location other than the proposed or to another property because soil and subsurface conditions are unique and site specific for different locations.

Our recommendations and conclusions are based on the site materials observed, engineering analyses, and our experience and engineering judgement. The conclusions and recommendations are professional opinions derived in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty is expressed or implied.

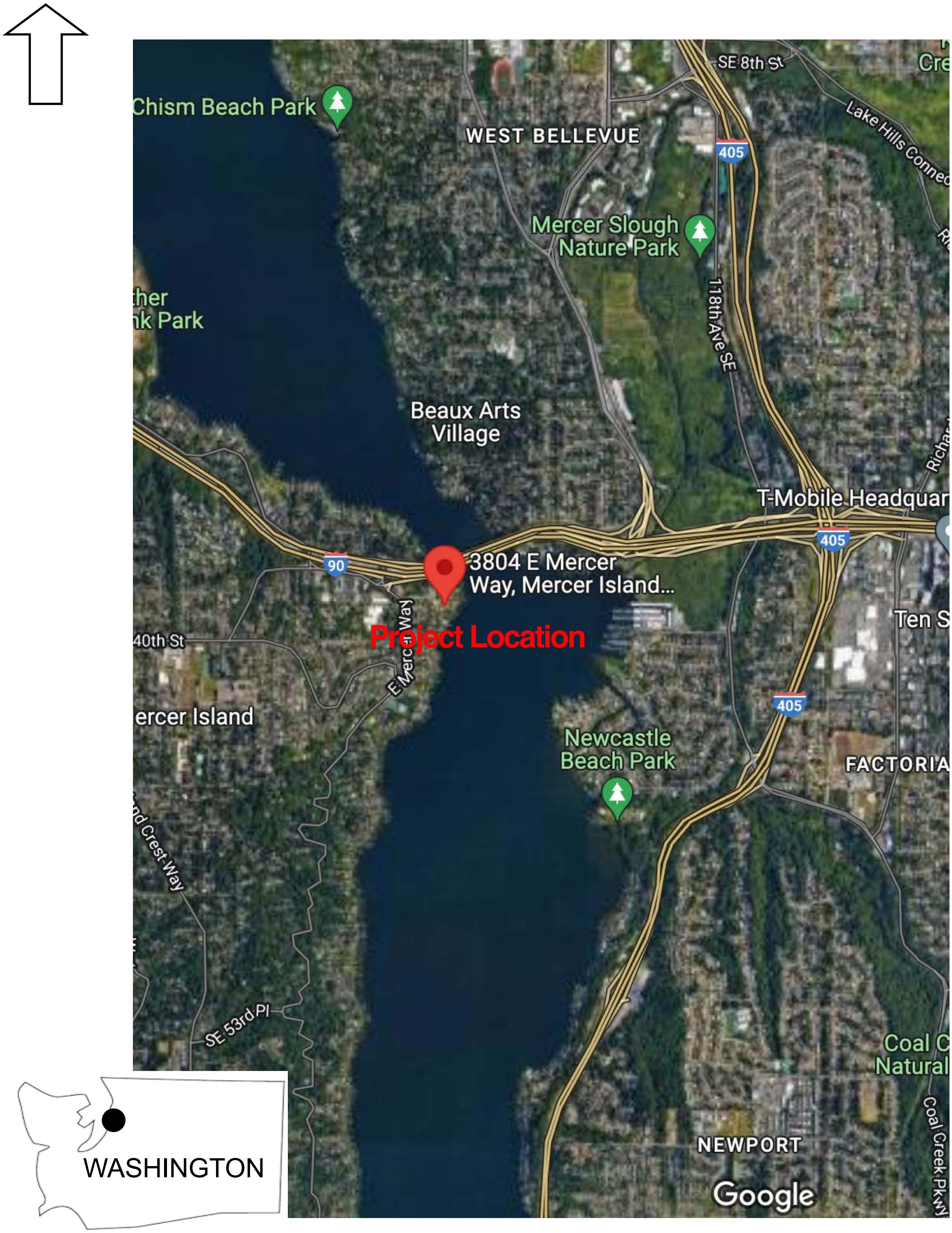
We recommend that we be retained consult and review the soil conditions when subsurface open up or during the construction phase of the project to confirm they are in accordance with the soils encountered in this report.

APPENDIX

Subsurface conditions at the site were investigated by conducting two (2) SPT borings on November 4, 2024 and two (2) test pits on November 26, 2022. Test locations were determined by a representative of Merit Engineering Inc. as shown approximately on the Site Plan (Figure 2) presented in the Appendix of this report. Tests were conducted near the adjacent to the building footprint to generalize subsurface soil conditions. Depths referred to in this report are relative to the existing ground surface at the time of this field investigation.

Descriptions of subsurface conditions are based on observations made at the site at the time of the field investigation. SPT boring and test pit logs are presented in Figures 4 through 7. The soils observed at the site were classified using the USCS (Unified Soils Classification System) in accordance with ASTM D-2488-69 and ASTM D 2487. This classification system is also presented in the Appendix (Figure 3).

MERCER ISLAND, WASHINGTON

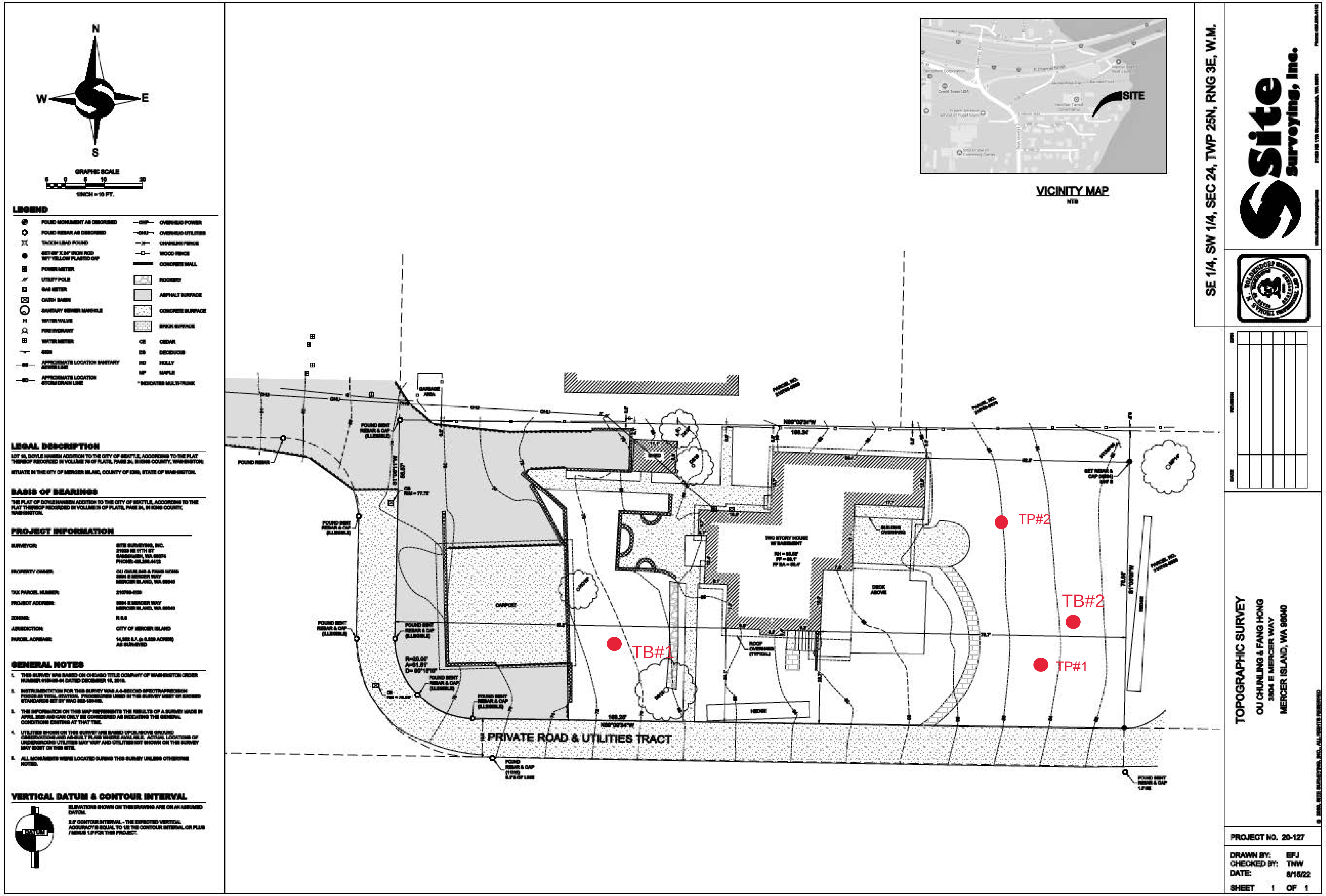


Project No. 2DK0233995	**PROJECT LOCATION & VICINITY MAP**	Date: 11/26/2022	*Figure 1*

Proposed Single Family House
3804 R Mercer Way
Mercer Island, Washington 98040

Prepared For: Chunling Ou

MERIT ENGINEERING INC.
10129 Main Street, #201
Bellevue, Washington 98004
Telephone: (425)454-2133
http://www.MeritEngineering.com



MERCER ISLAND, WASHINGTON

Note:

The site plan was based on the map from Site Surveying, Inc.

Proposed Single Family House
3804 R Mercer Way
Mercer Island, Washington 98040

Prepared For: Chunling Ou

SITE PLAN

Figure 2	PROJECT NO.	DATE	APPROVED BY
Scale: Not to Scale	2DK0233995	11/29/2024	AXH

MERIT ENGINEERING INC.
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http://www.MeritEngineering.com

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS				DESCRIPTION	
COARSE GRAINED SOILS more than 50% retained on #200 sieve	**GRAVELS** more than 50% coarse fraction is larger than No. 4 sieve size	Gravels with less than 5% fines	░	GW	Well graded gravels, gravel-sand mixtures
			▤	GP	Poorly graded gravels, gravel-sand mixtures
		Gravels with more than 12% fines	░	GM	Silty gravels, gravel-sand-silt mixtures
			▤	GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS more than 50% coarse fraction is smaller than No. 4 sieve size	Sands with less than 5% fines	░	SW	Well graded sands, gravelly sands
			▒	SP	Poorly graded sands, gravelly sands
		Sands with more than 12% fines	▩	SM	Silty sands, sand-silt mixtures
			░	SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS more than 50% passing #200 sieve	**SILTS AND CLAYS** Liquid Limit less than 50		▥	ML	Inorganic silts & 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, or lean clays
			▤	OL	Organic clays and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid Limits greater than 50		▥	MH	Inorganic silts, micaceous or diatomacious fine, sandy or silty soils, elastic silts
			▨	CH	Inorganic clays of high plasticity, fat clays
			▦	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			░	PT	Peat and other highly organic soils
UNCONTROLLED FILL			▒		Uncontrolled, with highly variable constituents

LEGEND

SAMPLE		SYMBOL	
▨	SPLIT SPOON SAMPLER	∇	GROUNDWATER TABLE
■	SHELBY TUBE SAMPLER	q_u	PENETROMETER READING TSF (*tons per square foot*)

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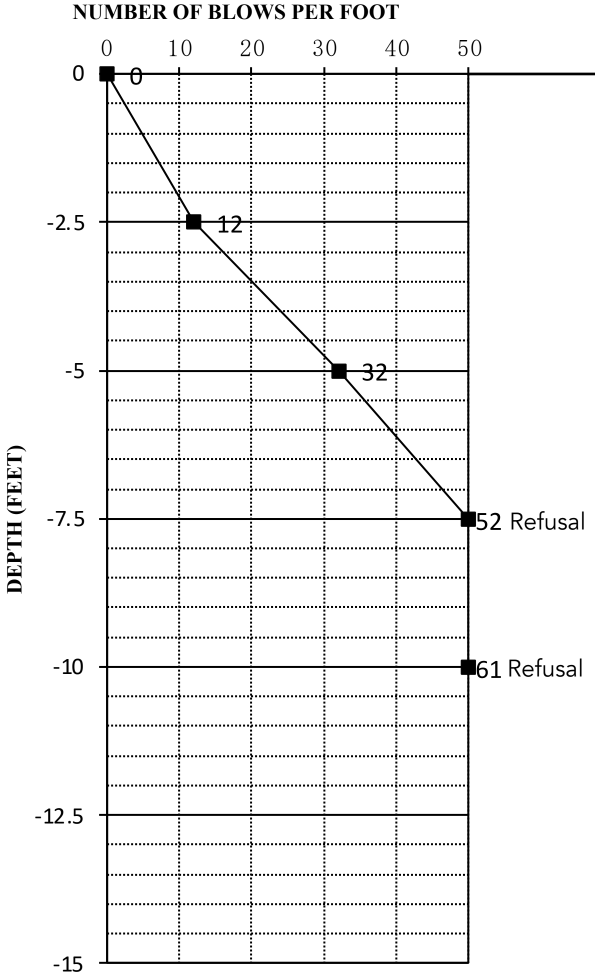
SOIL CLASSIFICATION & LEGEND

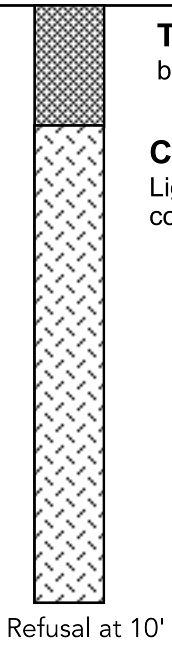
Figure 3

TB-1 STANDARD PENETRATION TEST

SOIL DESCRIPTION AND CLASSIFICATION

X,Y =
Surface Elevation = 70'
Surface Conditions = Grass Land





TOPSOIL (SM)
black loose silty sand with orgainc roots.

CLAYEY SANDS (SC)(GLACIAL TILL)
Light brown/gray clayey sand with gravel,
cobbles dense to very dense and dry.

Note: Drilling was terminated at 10' on 11/04/2024. Water Seepage was not observed during drilling.

Project No: 2DK0233995	Date: 11/29/2024	**LOG OF SPT**	Approved by AXH	Figure 4

Proposed Single Famliy House
3804 E Mercer Way
Mercer Island, WA 98040

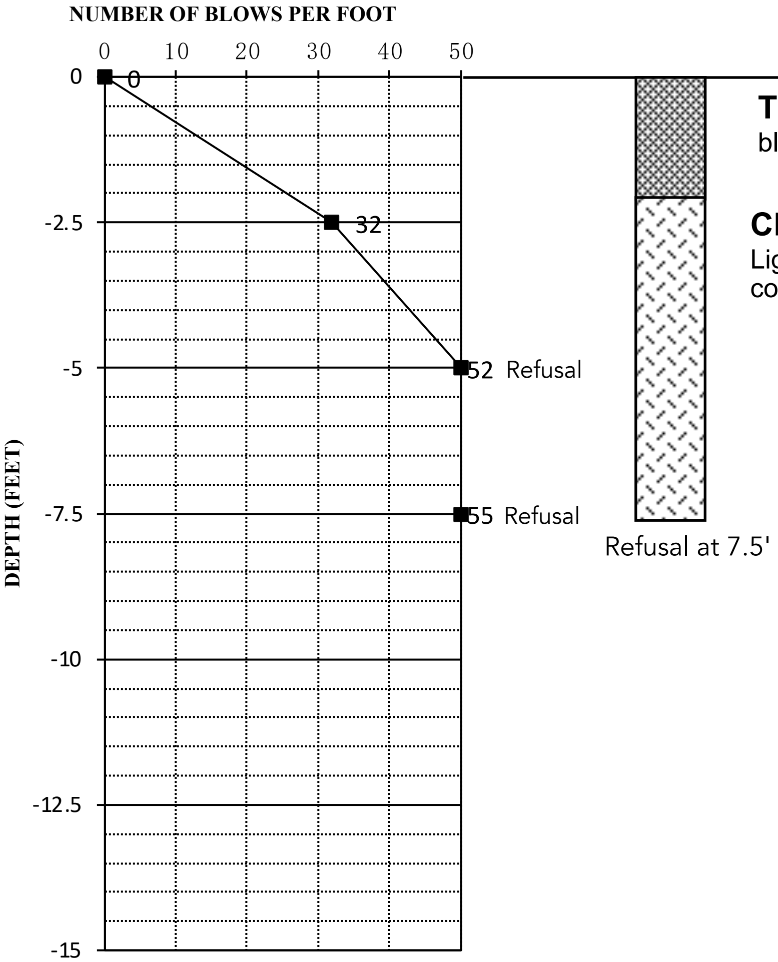
For: Chunling Ou

MERIT ENGINEERING INC.
10129 Main Street #201
Bellevue, Washington 98004
Telephone: (425)454-2133
http://www.MeritEngineering.com

TB-2 STANDARD PENETRATION TEST

SOIL DESCRIPTION AND CLASSIFICATION

X,Y =
Surface Elevation = 54'
Surface Conditions = Grass Land



TOPSOIL (SM)
black loose silty sand with orgainc roots.

CLAYEY SANDS (SC)(GLACIAL TILL)
Light brown/gray clayey sand with gravel,
cobbles dense to very dense and dry.

Note: Drilling was terminated at 7.5' on 11/04/2024. Water Seepage was not observed during drilling.

Project No: 2DK0233995	Date: 11/29/2024	**LOG OF SPT**	Approved by AXH	Figure 5

Proposed Single Famliy House
3804 E Mercer Way
Mercer Island, WA 98040

For: Chunling Ou

MERIT ENGINEERING INC.
10129 Main Street #201
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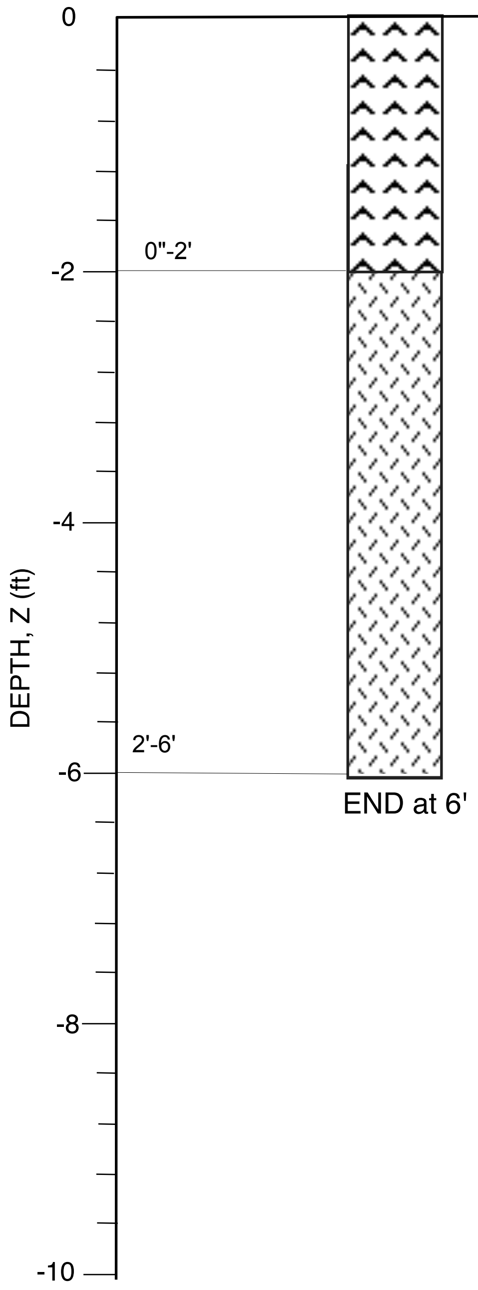
http://www.MeritEngineering.com

TP - 1	Surface Elevation ≈ 55 X = Y =	SOIL DESCRIPTION AND CLASSIFICATION



TOPSOIL (OL)
Black organic silty sand with grassroots moist, loose

CLAYEY SANDS WITH GRAVEL(TILL)
Gray clayey sand with gravel, very stiff to hard, and damp.

Project No. 2DK0233995	Date: 11/26/2022	Approved by AH	*Figure 6*

Proposed Single Family House
3804 R Mercer Way
Mercer Island, Washington 98040

Prepared For: Chunling Ou

MERIT ENGINEERING INC.
10129 Main Street #201
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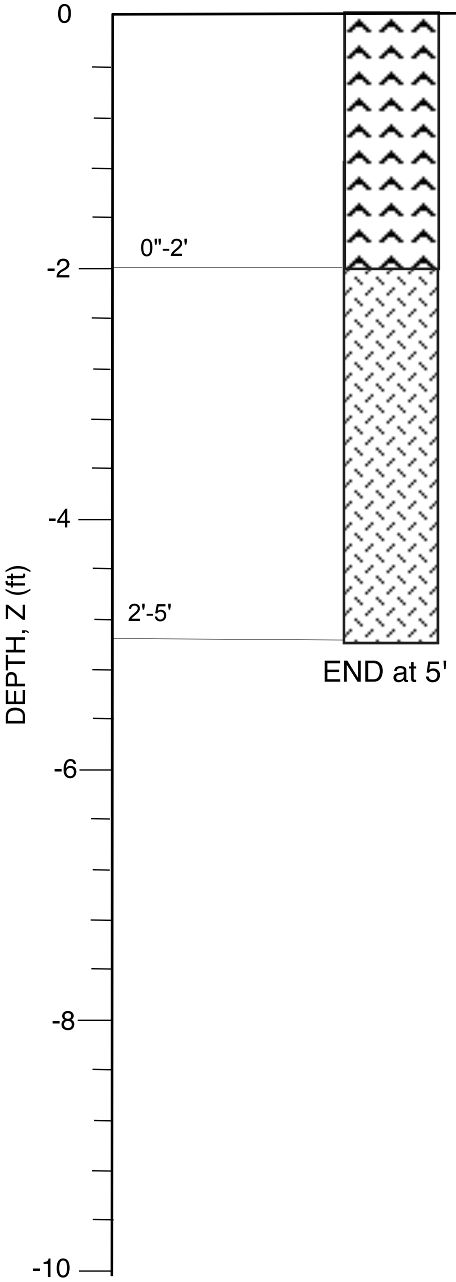
TP - 2	Surface Elevation ≈ 54 X = Y =	SOIL DESCRIPTION AND CLASSIFICATION



Fill
Black organic silty sand with grassroots moist, loose, and some bricks.

CLAYEY SANDS WITH GRAVEL(TILL)
Gray clayey sand with gravel, very stiff to hard, and damp.

Project No. 2DK0233995	Date: 11/26/2022	Approved by AH	*Figure 7*

Proposed Single Family House
3804 R Mercer Way
Mercer Island, Washington 98040

Prepared For: Chunling Ou

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http://www.MeritEngineering.com

APPENDIX B

1406-032

PRELIMINARY GEOTECHNICAL ENGINEERING EVALUATION
GIBSON SHORT PLAT LOT 2 AND LOT 3
9980 SE 38TH STREET

MERCER ISLAND, WASHINGTON

PREPARED FOR
MR. SCOTT GIBSON

RECEIVED
JUN 03 2014
CITY OF MERCER ISLAND
DEVELOPMENT SERVICES

NGA
NELSON GEOTECHNICAL ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS & GEOLOGISTS

Main Office
17311 – 135th Ave NE, A-500
Woodinville, WA 98072
(425) 486-1669 · FAX (425) 481-2510

Engineering-Geology Branch
5526 Industry Lane, #2
East Wenatchee, WA 98802
(509) 665-7696 · FAX (509) 665-7692

April 4, 2014

Mr. Scott Gibson
On The Rock 98040, LLC
P.O. Box 956
Mercer Island, Washington 98040

Preliminary Geotechnical Engineering Evaluation
Gibson Short Plat Lot 2 and Lot 3
9980 SE 38th Street
Mercer Island, Washington
NGA File No. 891814

Dear Mr. Gibson:

We are pleased to submit the attached report titled "Preliminary Geotechnical Engineering Evaluation – Gibson Short Plat Lot 2 and Lot 3 – 9980 SE 38th Street – Mercer Island, Washington." We previously prepared a preliminary geotechnical report for the project titled "Preliminary Geotechnical Engineering Evaluation – Kathy Wangen 3-lot Residential Development – 3806 East Mercer Way – Mercer Island, Washington," dated June 16, 2005. As a part of this previous report, we provided our opinions and recommendations to develop single-family residences within the upper western lot now known as Lot #1 and the lower eastern lot now known as Lot #3. The existing residence for this project was located on the property now known as Lot #2. A new single-family residence has recently been constructed on Lot #1. This updated preliminary report summarizes the existing surface and subsurface conditions utilizing our recent and past explorations performed within the site and provides updated recommendations for the proposed site development within Lot #2 and Lot #3. Our services were completed in general accordance with the proposal signed by you on March 13, 2014.

The proposed development area within Lot #2 is generally situated on gentle to moderately sloping ground within the western and central portion of the lot. The eastern portion of Lot #2 descends moderately to steeply down from a relatively level yard area to the western side of a shared asphalt driveway. Within Lot #3, the ground surface descends steeply down from the eastern side of the driveway to a relatively level bench area that extends to the western shores of Lake Washington. Lot #2 is currently occupied by an existing single-family residence with a daylight basement and miscellaneous outbuildings, while Lot #3 is currently vacant as it was during our previous evaluation. Site conditions appear to have remained relatively unchanged since our previous report was prepared. The sites are generally vegetated with grass, underbrush, and scattered trees.

The planned improvements for both lots will include the construction of multi-level, single-family residences within the western and central portion of Lot #2, in the approximate location of the existing residence, and within the relatively level bench area of Lot #3. Final development and grading plans have not been developed; however, we anticipate that retaining walls will be needed for the construction of the residences and support of steep cuts. Final stormwater plans have also not been developed, but we anticipate that stormwater from the lots will be directed to existing systems within the shared driveway. We should be retained to review final residence plans, including plans for site grading, retaining walls, and drainage prior to construction.

We recently explored the proposed residence area within Lot #2 with two drilled borings using a track-mounted drill rig extending up to approximately 21.5 feet below the existing ground surface. As a part of our previous evaluation, we explored the proposed building area within Lot #3 and along the driveway above the proposed building area with a track-mounted drill rig and a limited-access drill rig, respectively. Our most recent and past explorations indicate that the site is generally underlain by competent native glacial till soils within Lot #2 and the upper western portion of Lot #3, and competent fine-grained deposits within the relatively level area within the eastern portion of Lot #3.

It is our opinion from a geotechnical standpoint that the site is compatible with the planned development within Lots #2 and #3, provided that our recommendations are incorporated into the design and construction of this project. We recommend that the residence foundations be designed to utilize conventional spread footings extending down to medium dense or better native soils for bearing capacity and settlement considerations. These soils should generally be encountered approximately two to four feet below the existing ground surface, based on our explorations. We should note that deeper areas of unsuitable soils and/or undocumented fill could be encountered in the unexplored areas of the site.

It is also our opinion that the soils that underlie the site and form the core of the site slopes should be stable with respect to deep-seated earth movements, due to their inherent strength and slope geometry. However, there is a potential for shallow sloughing and erosion events to occur on the steeper portions of this site. We recommend that the new residence and light structures such as decks and patios within Lot #2 be set back at least 15 feet from the top of the steep east-facing slope above the driveway within the eastern portion of Lot #2. Foundations for any decks/patios constructed along the eastern side of the residence in Lot #2 should be a minimum of three feet deep and structurally tied into the residence foundation with grade beams. We also recommend that the structure within Lot #3 be protected against potential slope movement on the uphill side of the residence by incorporating some type of a debris wall on that side. This is further discussed in the attached report. We have also provided general recommendations for retaining walls, site grading, subgrade preparation, drainage, and erosion control.

We recommend that NGA be retained to review the geotechnical aspects of the project plans prior to construction. We also recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications.

We appreciate the opportunity to provide service to you on this project. Please contact us if you have any questions regarding this report or require further information.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Khaled M. Shawish, PE
Principal

Three Copies Submitted

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LIST OF FIGURES

Preliminary Geotechnical Engineering Evaluation
Gibson Short Plat Lot #2 and Lot #3
9980 SE 38th Street
Mercer Island, Washington

INTRODUCTION

This report presents the results of our preliminary geotechnical engineering investigation and evaluation of the Gibson Short Plat Lot #2 and #3 project located at 9980 SE 38th Street on Mercer Island, Washington, as shown on the Vicinity Map in Figure 1. The Tax Parcel Numbers for Lot #2 and #3 are #082405-9033 and #082405-9327, respectively. The purpose of this study is to explore and characterize the site's surface and subsurface conditions and to provide preliminary geotechnical recommendations for site development. For our use in preparing this report, we have been provided with a site plan titled "A custom residence for - On the Rock 98040, LLC – Lot 2, 9980 SE 38th Street, Mercer Island," dated February 27, 2014, prepared by Anderson Architecture showing the existing and proposed site conditions, property boundaries, and topographic information. We previously prepared a preliminary geotechnical report for the project titled "Preliminary Geotechnical Engineering Evaluation – Kathy Wangen 3-lot Residential Development – 3806 East Mercer Way – Mercer Island, Washington," dated June 16, 2005.

The proposed development area within Lot #2 is generally situated on gentle to moderately sloping ground within the western and central portion of the lot. The eastern portion of Lot #2 descends moderately to steeply down from a relatively level yard area to the western side of a shared asphalt driveway. Within Lot #3, the ground surface descends steeply from the eastern side of the driveway to a relatively level bench area that extends to the western shores of Lake Washington. Lot #2 is currently occupied by an existing single-family residence with a daylight basement and miscellaneous outbuildings, while Lot #3 is currently vacant, as it was during our previous evaluation. Site conditions appear to have remained relatively unchanged since our previous report was prepared. The sites are generally vegetated with grass, underbrush, and scattered trees.

The planned improvements for both lots will include the construction of a multi-level, single-family residence within the western and central portion of Lot #2 in the approximate location of the existing residence, and within the relatively level bench area of Lot #3 along the toe of the steep slope. Final development and grading plans have not been developed; however, we anticipate that retaining walls will be needed for the construction of the residences and support of steep cuts. Final stormwater plans have also not been developed, but we anticipate that stormwater from the sites will be directed to existing systems within the shared driveway. The existing site conditions and proposed development areas are shown on the Site Plan in Figure 2.

SCOPE

The purpose of this study is to explore and characterize the site surface and subsurface conditions utilizing information gathered from our recent and past site evaluations, and provide general recommendations for site development. Specifically, our scope of services includes the following:

1. Review available soil and geologic maps of the area, updated plans as well as our previous report.
2. Explore the subsurface soil and groundwater conditions within Lot #2 with two drilled borings up to 21.5 feet deep using a track-mounted drill rig. Drill rig was subcontracted by NGA.
3. Map the conditions on the slope, perform hand-tool excavations, and evaluate current slope stability conditions.
4. Perform grain-size sieve analysis and classification of soil samples, as necessary.
5. Provide general recommendations for earthwork, foundation support, and slabs-on-grade.
6. Provide general recommendations for building setback from the steep slope and/or deepened footings.
7. Provide general recommendations for temporary and permanent slopes.
8. Provide general recommendations for retaining walls.
9. Provide general recommendations for site drainage and erosion control.
10. Document the results of our findings, conclusions, and recommendations in an updated addendum report.

SITE CONDITIONS

Surface Conditions

The site consists of two separate, irregular shaped parcels known as Lot #2 and #3, covering approximately 0.45 and 0.32 acres, respectively. The lots are accessed via a shared asphalt driveway that traverses the steep slope along the southern portion of Lot #2 and then bends to the north between Lots #2 and #3 and terminates along the northern portion of Lot #3. Lot #2 is currently occupied by an existing single-family residence within central portion of the lot, while Lot #3 is currently vacant. The ground surface within Lot #2 slopes gently to moderately down from the western property boundary to a steep cut slope along the western side of the access driveway within the eastern portion of the lot. The steep cut slope descends from the yard area to the western edge of the access driveway at an approximate inclination of 41 degrees (87 percent) with an approximate height ranging from 4 to 12 feet. Within Lot #3, a steep east-facing slope descends steeply from the eastern side of the driveway at a gradient of approximately 38 degrees (78 percent) within the western portion of the lot to a relatively level bench area within the central and eastern portion of the lot. The overall height of the steep east-facing slope below the driveway ranges from approximately 34 feet along the southern side of lot to 4 feet within the northern portion of the lot. This relatively level bench area extends to the western shores of Lake Washington within the eastern portion of the lot. The site layout is shown on the Site Plan in Figure 2. A profile of the site slopes through the lots and proposed development areas is shown on Cross Section A-A' in Figure 3.

The site is bordered by residential properties to the north, west, and south, and to the east by Lake Washington. The site is generally covered with grass, scattered trees and dense underbrush. We did not observe significant signs of surficial slope movement or groundwater seepage emitting from the slopes during our March 21, 2014 site visit. Site conditions appear to be similar as observed in our 2005 report.

Subsurface Conditions

Geology: The Geologic Map of Mercer Island, Washington, by Kathy G. Troost & Aaron P. Wisher, et al. (USGS, October 2006) was reviewed for this site. The site is mapped as Qvt (Vashon Till) and Qpon (Nonglacial deposits). The Vashon Till is described a compact diamict of silt, sand and subrounded to well-rounded gravel, glacially transported and deposited under ice. The Nonglacial deposits are described as sand, gravel, silt and clay inferred as nonglacial in origin. In general, we encountered silty fine to medium sand with gravel soils within our explorations performed within Lots 1, 2 and the western portion of Lot 3 that we interpreted as native Vashon Till soils. In our exploration performed within the lower, relatively level central and eastern portion of Lot 3, we encountered silt with varying amounts of fine sand that we interpreted as older non-glacial deposits.

Explorations

We recently visited the site on March 21, 2014 to explore the subsurface soil and groundwater conditions by drilling two exploratory borings using a track-mounted drill rig within Lot 2. Our explorations were located within the vicinity of the proposed residence within Lot 2. We also previously performed two exploratory borings on May 20, 2005 using a track-mounted drill rig on Lots 1 and 3. An exploratory boring was also performed along the eastern side of the shared driveway using a limited-access drill rig on May 25, 2005. The approximate locations of our recent and past explorations are indicated on the Site Plan in Figure 2.

A geologist from Nelson Geotechnical Associates, Inc. (NGA) was present during the explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the explorations. A Standard Penetration Test (SPT) was performed on each of the samples during drilling to document soil density at depth. The SPT consists of driving a 2-inch outer-diameter, split-spoon sampler 18 inches using a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler the final 12 inches is referred to as the "**N**" value and is presented on the boring logs. The **N** value is used to evaluate the strength and density of the deposit.

The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 4. The logs of our recent borings are presented as Figures 5 and 6. The logs of our previous borings are presented as Figures 7 through 9. The following paragraphs contain a general description of the subsurface conditions encountered in the explorations. For a detailed description of the subsurface conditions, the boring logs should be reviewed.

In our recent Borings B-101 and 102 within Lot 2, we encountered up to approximately 5.0 feet of medium dense to dense, brown-gray silty fine to medium sand with gravel that we interpreted as native weathered glacial till soils. Underlying the weathered till soils, we encountered medium dense to very dense/hard, gray fine to medium sand with silt and gravel; silty fine to medium sand with gravel; and silt with trace fine sand that we interpreted as native unweathered glacial till soils. Borings B-101 and B-102 were terminated in the unweathered glacial till deposits at depths of 15.5 to 21.0 feet below the existing ground surface, respectively.

In our previous Boring B-1 performed within Lot 1, we encountered up to 9.0 feet of very loose, silty fine to coarse sand with gravel and trace organics that we interpreted as undocumented fill soils. Underlying the undocumented fill in Boring B-1 and a surficial layer of topsoil in Boring B-3 that was previously performed along the eastern side of the shared driveway, we encountered dense to very dense, fine to medium sand with silt and gravel; silty fine to medium sand with gravel, and silt with varying amounts of sand that we interpreted as native glacial till soils. Our previous Borings B-1 and B-3 were terminated within the native glacial till soils at depths of 31.5 and 9.0 feet, respectively.

In our previous Boring B-2 performed within the central portion of Lot 3, we encountered hard, silt with varying amounts of fine sand and gravel that we interpreted as older non-glacial deposits. Our previous Boring B-2 was terminated within the older non-glacial deposits at a depth of 26.5 feet below the existing ground surface.

Hydrologic Conditions

Light groundwater seepage was encountered in our recent Boring B-101 at 20.0 feet below the existing ground surface. We also encountered light groundwater seepage in our previous Boring B-1 at 18.0 feet below the existing ground surface. We interpreted this seepage as perched groundwater. We anticipate that perched water conditions may develop on this site during extended periods of wet weather. Perched water occurs when surface water infiltrates through less dense, more permeable soils, such as topsoil and the weathered horizon, and accumulates on top of a less permeable soil, such as the dense glacial soils. Perched water does not represent a regional groundwater "table" within the upper soil horizons. Perched water tends to vary spatially and is dependent upon the amount of rainfall. We would expect the amount of groundwater to decrease during drier times of the year and increase during wetter periods.

SENSITIVE AREA EVALUATION

Seismic Hazard

We reviewed the 2012 International Building Code (IBC) for seismic site classification for this project. Since competent glacial soils were encountered underlying the site, the site conditions best fit the IBC description for Site Class D.

Hazards associated with seismic activity include liquefaction potential and amplification of ground motion by soft deposits. Liquefaction is caused by a rise in pore pressures in a loose, fine sand deposit beneath the groundwater table. The competent glacial soils interpreted to underlie the site have a low potential for liquefaction or amplification of ground motion.

The medium dense or better native glacial soils interpreted to form the core of the site slopes is considered stable with respect to deep-seated slope failures. However, the overlying loose surficial materials located on the site slopes, especially the steep slope on Lot #3 below the existing driveway, have the potential for shallow sloughing failures during seismic events. Such events should not affect the planned residences provided the foundations and debris protection systems are designed and constructed in accordance with the recommendations described in this report.

Erosion Hazard

The criteria used for determination of the erosion hazard for affected areas include soil type, slope gradient, vegetation cover, and groundwater conditions. The erosion sensitivity is related to vegetative cover and the specific surface soil types, which are related to the underlying geologic soil units. The Soil Survey of the King County Area, Washington, by the Soil Conservation Service (SCS) was reviewed to determine the erosion hazard of the on-site soils. The surficial soil on site is mapped as Alderwood gravelly sandy loam, 6 to 15 percent slopes. The erosion hazard for this material is listed as moderate. During the wetter periods of the year, we would also expect some erosion of the exposed soils on the steep slopes. This type of erosion is usually associated with weathering processes, including direct precipitation, wind, and freeze-thaw conditions. All undisturbed, vegetated areas should have a low to moderate erosion hazard depending on how surface water is controlled on the site.

Landslide Hazard/Slope Stability

The criteria used for evaluation of landslide hazards include soil type, slope gradient, and groundwater conditions. The lots are generally situated on gently to moderately sloping ground with steep east-facing slopes at inclinations of approximately 38 to 41 degrees (78 to 87 percent) on the uphill western side of the access driveway within Lot #2 and the downhill eastern side of the access driveway within Lot #3. We did not observe evidence of significant slope instability during our investigation, such as deep-seated landsliding.

The core of the slope is inferred to consist primarily of medium dense/stiff or better native glacial deposits. An inclination of up to 41 degrees on the site slopes indicates high strength and internal friction angle within the underlying soils. Relatively shallow sloughing failures as well as surficial erosion are natural processes and should be expected on this slope during extreme weather conditions. It is our opinion that while there is potential for erosion, soil creep, and shallow failures within the loose surficial soils on the slope, there is not a significant potential for deep-seated slope failure under current site conditions. Proper site grading, drainage, and foundation placement as recommended in this report should help reduce the impact of such events on the planned improvements. We recommend incorporating a debris structure into the upslope sides of the residence foundation within Lot #3 to help protect the residence against potential failures within the slope above.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion that the preliminary planned development within Lot #2 and #3 is feasible from a geotechnical standpoint. It is also our opinion that the soils that underlie the site and form the core of the site slopes should be stable with respect to deep-seated earth movements, due to their inherent strength and slope geometry. However, there is a potential for shallow sloughing and erosion events to occur on the steep slopes within the site. The frequency and severity of such events will be greatly impacted by weather conditions and human activity on the slope. Proper erosion and drainage control measures, along with long-term maintenance of the slope and drainage systems as recommended in this report, should reduce this potential. We recommend that we review the plans after they have been developed.

Our explorations indicate that Lot #2 and the western portion of Lot #3 are generally underlain by medium dense or better native glacial till soils while the relatively level, eastern portion of the Lot #3 is underlain by hard, native fine-grained deposits. The native soils encountered in the lots should provide adequate support for foundation and slab loads. We recommend that the structures be designed utilizing shallow conventional foundations. Footings should extend through any undocumented fill or loose soil, and be founded on the underlying medium dense or better native soil, or structural fill extending to these soils. The medium dense/stiff or better soil should typically be encountered approximately two to four feet below the existing ground surface, based on our explorations.

To protect the residence within Lot #2 against potential failures on the slope below this lot, we recommend that the residence be setback at least 15 feet from the top of the steep slope within the eastern portion of Lot #2. Supports for decks and/or patios placed along the eastern side of the residence should be embedded a minimum of three feet into the ground and be structurally tied back to the residence foundation with grade beams. We should be retained to review final residence location within Lot #2.

We understand that the residence within Lot #3 may be constructed along the toe of the steep slope located below the access driveway within the eastern portion of the lot. In our opinion, this should be feasible provided the foundation walls along the upslope sides of the residence be designed as recommended in this report. We recommend that the upslope portions of the residence foundation within Lot #3 be designed as debris walls and extend a minimum of three feet above finished ground surface to protect the structure against potential failures on this slope. This is intended to provide a catchment measure should any sloughing debris travel towards the residence during extreme weather or as a result of an earthquake. Alternatively, a separate debris protection structure could be utilized.

Construction of the proposed residences may require cuts greater than four feet in height. Cuts over four feet in height should be shored or sloped back to maintain stability. This is essential to maintaining overall slope stability. We should be retained to review proposed grading plans prior to construction.

All grading operations and drainage improvements planned as part of this development should be planned and completed in a matter that enhances the stability of the site slopes, not reduces it. Excavation spoils should not be stockpiled near or on sloping ground or be allowed to encroach on the slopes. Also, runoff generated within the site should be collected and routed into a permanent discharge system and not be allowed to flow over the slopes. Future vegetation management on the slopes should be the subject of a specific evaluation and a plan approved by the City of Mercer Island. We recommend that the trees on the slope be evaluated by a certified arborist, and hazardous trees on the slope that may endanger the residences be removed prior to residence construction. The slopes should be monitored on an on-going basis, especially during the wet season, for any signs of instability, and corrective actions promptly taken should any signs of instability be observed.

The surficial soils encountered on this site are considered moisture-sensitive and could disturb when wet. To lessen the potential impacts of construction on the slopes and to reduce cost overruns and delays, we recommend that construction take place during the drier summer months. If construction takes place during the rainy months, additional expenses and delays should be expected. Additional expenses could include the need for placing erosion control and temporary drainage measures to protect the slopes, the need for placing a blanket of rock spalls on exposed subgrades, and construction traffic areas prior to placing structural fill, and the need for importing all-weather material for structural fill.

Under no circumstances, should water be allowed to flow over or concentrate on the site slopes, both during construction and after construction has been completed. We recommend that stormwater runoff from the roof and yard drains be collected and tightlined to a suitable discharge point. The slopes should be protected from erosion. We recommend that all disturbed areas be replanted with vegetation to re-establish vegetation cover as soon as possible. Specific recommendations for erosion control are presented in the **Erosion Control and Slope Protection Measures** subsection of this report.

Erosion Control and Slope Protection Measures

The erosion hazard for the on-site soils is listed as moderate, but the actual hazard will be dependent on how the site is graded and how water is allowed to concentrate. Best Management Practices (BMPs) should be used to control erosion. Areas disturbed during construction should be protected from erosion. Erosion control measures may include diverting surface water away from the stripped or disturbed areas. Silt fences and/or straw bales should be erected to prevent muddy water from leaving the site or flowing over the slopes. Stockpiles should be covered with plastic sheeting during wet weather. Disturbed areas should be planted as soon as practical and the vegetation should be maintained until it is established. The erosion potential for areas not stripped of vegetation should be low.

Protection of the slope areas should be performed as required by the City of Mercer Island. Specifically, we recommend that the slope not be disturbed or modified through placement of any fill or removal of the existing vegetation. Trees should not be cut down or removed from the slopes unless a mitigation plan is developed, such as the replacement of vegetation for erosion protection. Vegetation should not be removed from the slopes. Replacement of vegetation should be performed in accordance with City of Mercer Island code. Any proposed development within the steep slope area should be the subject of a specific geotechnical evaluation.

Site Preparation and Grading

After erosion control measures are implemented, site preparation should consist of stripping any loose soils to expose medium dense or better native soil in foundation, slab-on-grade, and pavement areas. The stripped materials should be removed from the site or stockpiled for later use as landscaping fill. Stockpiles should be kept away from the top of the steep slopes and should be covered with plastic during wet weather.

If the exposed subgrade, after site stripping, should appear to be loose, it should be compacted to a non-yielding condition. Areas observed to pump or weave during compaction should be over-excavated and replaced with properly compacted structural fill or rock spalls. If loose soils are encountered in the subgrade, the loose soils should be removed and replaced with rock spalls or granular structural fill. If significant surface water flow is encountered during construction, this flow should be diverted around areas to be developed, and the exposed subgrades should be maintained in a semi-dry condition.

If wet conditions are encountered, alternative site stripping and grading techniques might be necessary. These methods could include using large excavators equipped with wide tracks and a smooth bucket to complete site grading and covering exposed subgrade with a layer of crushed rock for protection. If wet conditions are encountered or construction is attempted in wet weather, the subgrade should not be compacted as this could cause further subgrade disturbance. In wet conditions it may be necessary to cover the exposed subgrade with a layer of crushed rock as soon as it is exposed to protect the moisture sensitive soils from disturbance by machine or foot traffic during construction. The prepared subgrade should be protected from construction traffic and surface water should be diverted around prepared subgrade. Shallow groundwater, if encountered, should be intercepted with cut off drains and routed around the planned grading area, or the groundwater should be controlled with sump-pumps or dewatering systems.

Structure Setbacks

Uncertainties related to building along steep slopes are typically addressed by the use of building setbacks. The purpose of the setback is to establish a "buffer zone" between the structure and the top of the slope so that ample room is allowed for normal slope recession during a reasonable life span of the structure. In a general sense, the greater the setback distance, the lower the risk of slope failures impacting the structure. From a geological standpoint, the setback dimension is based on the slope's physical characteristics, such as slope height, surface angle, material composition, and hydrology. Other factors such as historical slope activity, rate of regression, and the type and desired life span of the development are important considerations as well.

We recommend that the residence within Lot #2 be set back at least 15 feet from the top of the steep east-facing slope along the uphill, western side of the driveway within the eastern portion of the lot. The downhill foundation lines for this residence should be embedded a minimum of three feet into the competent native soils. We recommend that light structures such as decks or patios be supported on foundations also advanced a minimum of three feet below ground surface and be tied into the residence foundation with grade beams.

We should be retained to evaluate the residence foundation setback distances and subgrade soil prior to placing foundation forms. Any proposed development within the setback area or on the slope should be the subject of a specific geotechnical evaluation. Under no circumstances should water be allowed to concentrate on the slopes, during or after construction.

Temporary and Permanent Slopes

Temporary cut slope stability is a function of many factors, including the type and consistency of soils, depth of the cut, surcharge loads adjacent to the excavation, length of time a cut remains open, and the presence of surface water or groundwater. It is exceedingly difficult under these variable conditions to estimate a stable, temporary, cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations since they are continuously at the job site, able to observe the soil and groundwater conditions encountered, and able to monitor the nature and condition of the cut slopes.

The following information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Nelson Geotechnical Associates, Inc. assumes responsibility for job site safety. Job site safety is the sole responsibility of the project contractor.

For planning purposes, we recommend that temporary cuts in the on-site soils be no steeper than 1.5 Horizontal to 1 Vertical (1.5H:1V). If significant groundwater seepage or surface water flow were encountered, we would expect that flatter inclinations would be necessary. We recommend that cut slopes be protected from erosion. The slope protection measures may include covering cut slopes with plastic sheeting and diverting surface runoff away from the top of cut slopes. We do not recommend vertical slopes for cuts deeper than four feet, if worker access is necessary. We recommend that cut slope heights and inclinations conform to appropriate OSHA/WISHA regulations.

Permanent cut and fill slopes should be no steeper than 2H:1V. However, flatter inclinations may be required in areas where loose soils are encountered. Permanent slopes should be vegetated and the vegetative cover maintained until established. We should specifically review all plans for grading near or on steep slopes for this project.

Foundation Support

Conventional shallow spread foundations should be placed on medium dense/stiff or better native soils, or be supported on structural fill or rock spalls extending to those soils. Medium dense/stiff soils should be encountered approximately two to four feet below the existing ground surface based on our explorations. Where undocumented fill or less dense soils are encountered at footing bearing elevation, the subgrade should be over-excavated to expose suitable bearing soil. If footings are supported on structural fill, the fill zone should extend outside the edges of the footing a distance equal to one-half of the depth of the over-excavation below the bottom of the footing.

Footings should extend at least 18 inches below the lowest adjacent finished ground surface for frost protection and bearing capacity considerations. Foundations should be designed in accordance with the 2012 IBC. Footing widths should be based on the anticipated loads and allowable soil bearing pressure. Water should not be allowed to accumulate in footing trenches. All loose or disturbed soil should be removed from the foundation excavation prior to placing concrete.

For foundations constructed as outlined above, we recommend an allowable design bearing pressure of not more than 2,000 pounds per square foot (psf) be used for the design of footings founded on the medium dense/stiff or better native soils or structural fill extending to the competent native material. The foundation bearing soil should be evaluated by a representative of NGA. We should be consulted if higher bearing pressures are needed. Current IBC guidelines should be used when considering increased allowable bearing pressure for short-term transitory wind or seismic loads. Potential foundation settlement using the recommended allowable bearing pressure is estimated to be less than one-inch total and ½-inch differential between adjacent footings or across a distance of about 20 feet, based on our experience with similar projects.

Lateral loads may be resisted by friction on the base of the footing and passive resistance against the subsurface portions of the foundation. A coefficient of friction of 0.35 may be used to calculate the base friction and should be applied to the vertical dead load only. Passive resistance may be calculated as a triangular equivalent fluid pressure distribution. An equivalent fluid density of 200 pounds per cubic foot (pcf) should be used for passive resistance design for a level ground surface adjacent to the footing. This level surface should extend a distance equal to at least three times the footing depth. These recommended values incorporate safety factors of 1.5 and 2.0 applied to the estimated ultimate values for frictional and passive resistance, respectively. To achieve this value of passive resistance, the foundations should be poured "neat" against the native medium dense/stiff or better soils or compacted fill should be placed against the footing. We recommend that the upper one-foot of soil be neglected when calculating the passive resistance.

Retaining Walls

We anticipate that retaining walls will be needed for the construction of the residence along the upslope side of the residences. The lateral pressure acting on subsurface retaining walls is dependent on the nature and density of the soil behind the wall, the amount of lateral wall movement which can occur as backfill is placed, wall drainage conditions, and the inclination of the backfill. For walls that are free to yield at the top at least one thousandth of the height of the wall (active condition), soil pressures will be less than if movement is limited by such factors as wall stiffness or bracing (at-rest condition). We recommend that walls supporting horizontal backfill and not subjected to hydrostatic forces, be designed using a triangular earth pressure distribution equivalent to that exerted by a fluid with a density of 40 pcf cantilevered) for yielding (active condition) walls, and 60 pcf for non-yielding restrained (at-rest condition) walls. The debris wall recommended on the uphill side of the residence within Lot 3 should be designed for an active pressure of 100 pcf.

These recommended lateral earth pressures are for a drained granular backfill and are based on the assumption of a horizontal ground surface behind the wall for a distance of at least the subsurface height of the wall, and do not account for surcharge loads. Additional lateral earth pressures should be considered for surcharge loads acting adjacent to subsurface walls and within a distance equal to the subsurface height of the wall. This would include the effects of surcharges such as traffic loads, floor slab loads, slopes, or other surface loads. We could consult with the structural engineer regarding additional loads on retaining walls during final design, if needed.

The lateral pressures on walls may be resisted by friction between the foundation and subgrade soil, and by passive resistance acting on the below-grade portion of the foundation. Recommendations for frictional and passive resistance to lateral loads are presented in the **Foundations** subsection of this report.

All wall backfill should be well compacted as outlined in the **Structural Fill** subsection of this report. Care should be taken to prevent the buildup of excess lateral soil pressures, due to over-compaction of the wall backfill. This can be accomplished by placing wall backfill in eight-inch loose lifts and compacting the backfill with small, hand-operated compactors within a distance behind the wall equal to at least one-half the height of the wall. The thickness of the loose lifts should be reduced to accommodate the lower compactive energy of the hand-operated equipment. The recommended level of compaction should still be maintained.

Permanent drainage systems should be installed for retaining walls. Recommendations for these systems are found in the **Subsurface Drainage** subsection of this report. We recommend that we be retained to evaluate the proposed wall drain backfill material and observe installation of the drainage systems.

Slab-on-Grade

Slabs-on-grade should be supported on subgrade soils prepared as described in the **Site Preparation and Grading** subsection of this report. We recommend that all floor slabs be underlain by at least six inches of free-draining gravel with less than three percent by weight of the material passing Sieve #200 for use as a capillary break. We recommend that the capillary break be hydraulically connected to the footing drain system to allow free drainage from under the slab. A suitable vapor barrier, such as heavy plastic sheeting (6-mil minimum), should be placed over the capillary break material. An additional 2-inch thick moist sand layer may be used to cover the vapor barrier. This sand layer is optional and is intended to protect the vapor barrier membrane during construction. We have provided additional recommendations regarding this system in the **Subsurface Drainage** subsection of this report.

Structural Fill

General: Fill placed beneath foundations, slabs, pavements, or other settlement-sensitive structures should be placed as structural fill. Structural fill, by definition, is placed in accordance with prescribed methods and standards, and is monitored by an experienced geotechnical professional or soils technician. Field monitoring procedures would include the performance of a representative number of in-place density tests to document the attainment of the desired degree of relative compaction. The area to receive the fill should be suitably prepared as described in the **Site Preparation and Grading** subsection prior to beginning fill placement. Sloping ground to receive fill should be benched to maintain fill stability. The benches should be level and have a minimum width of six feet.

Materials: Structural fill should consist of a good quality, granular soil, free of organics and other deleterious material, and be well graded to a maximum size of about three inches. All-weather structural fill should contain no more than five-percent fines (soil finer than U.S. No. 200 sieve, based on that fraction passing the U.S. 3/4-inch sieve). The use of some of the on-site soils as structural fill may be feasible but will be highly dependent on moisture content of the material at the time construction takes place. We should be retained to evaluate proposed structural fill material prior to placement.

Fill Placement: Following subgrade preparation, placement of structural fill may proceed. All filling should be accomplished in uniform lifts up to eight inches thick. Each lift should be spread evenly and be thoroughly compacted prior to placement of subsequent lifts. All structural fill should be compacted to a minimum of 95 percent of its maximum dry density. Maximum dry density, in this report, refers to that density as determined by the ASTM D-1557 Compaction Test procedure. The moisture content of the soils to be compacted should be within about two percent of optimum so that a readily compactable condition exists. It may be necessary to over-excavate and remove wet soils in cases where drying to a compactable condition is not feasible. All compaction should be accomplished by equipment of a type and size sufficient to attain the desired degree of compaction.

Site Drainage

Surface Drainage: Final site grades should allow for drainage away from steep slopes and away from the planned residences. We suggest that the finished ground be sloped at a minimum gradient of three percent for a distance of at least 10 feet away from the building. Runoff generated on this site should be collected and routed into a permanent discharge system such as the existing system within the driveway. This should include all downspouts and runoff generated on all hard surfaces and yards areas. Under no circumstances should water be allowed to flow uncontrolled over the slopes. Water should not be allowed to collect in any area where footings or slabs are to be constructed.

Subsurface Drainage: If groundwater is encountered during construction, we recommend that the contractor slope the bottom of the excavation and collect the water into ditches and small sump pits where the water can be pumped out of the excavation and routed into a suitable outlet. We recommend that the residence down spouts and footing drains be tightlined to an appropriate discharge location.

We recommend the use of footing drains around structures. Footing drains should be installed at least one foot below planned finished floor elevation. The drains should consist of a minimum 4-inch-diameter, rigid, slotted or perforated, PVC pipe surrounded by free-draining material wrapped in a filter fabric. We recommend that the free-draining material consist of an 18-inch-wide zone of clean (less than three-percent fines), granular material placed along the back of walls. Washed rock is an acceptable drain material, or drainage composite may be used instead. The free-draining material should extend up the wall to one foot below the finished surface. The top foot of soil should consist of low permeability soil placed over plastic sheeting or building paper to minimize the migration of surface water or silt into the footing drain. Footing drains should discharge into tightlines leading to an appropriate collection and discharge point with convenient cleanouts to prolong the useful life of the drains. Roof drains should not be connected to wall or footing drains.

CONSTRUCTION MONITORING

We recommend that we be retained to provide construction monitoring services to evaluate conditions encountered in the field with respect to anticipated conditions, to provide recommendations for design changes should the conditions differ from anticipated, and to evaluate whether construction activities comply with contract plans and specifications.

USE OF THIS REPORT

NGA has prepared this preliminary report for Scott Gibson and his agents for use in the planning and design of the development planned on this site only. The scope of our work does not include services related to construction safety precautions and 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. There are possible variations in subsurface conditions between the explorations and also with time. Our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions. A contingency for unanticipated conditions should be included in the budget and schedule. We recommend that we be retained to review the project plans after they have been developed to determine that recommendations in the report were incorporated into project plans.

All people who own or occupy homes on hillsides should realize that landslide movements are always a possibility. The landowner should periodically inspect the slope, especially after a winter storm. If distress is evident, a geotechnical engineer should be contacted for advice on remedial/preventative measures. The probability that landsliding will occur is substantially reduced by the proper maintenance of drainage control measures at the site (the runoff from the roofs should be led to an approved discharge point). Therefore, the homeowner should take responsibility for performing such maintenance. Consequently, we recommend that a copy of our report be provided to any future homeowners of the property if the home is sold.

We recommend that NGA be retained to review final plans prior to construction. We also recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications. We should be contacted a minimum of one week prior to construction activities and could attend pre-construction meetings if requested.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this report was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

o-O-o

It has been a pleasure to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

LEE S. BELLAH

Lee S. Bellah, LG
Project Geologist

KHALED M. SHAWISH
35215
EXPIRES 7/28/15

4/4/14

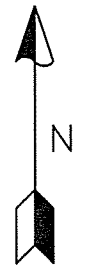
Khaled M. Shawish, PE
Principal

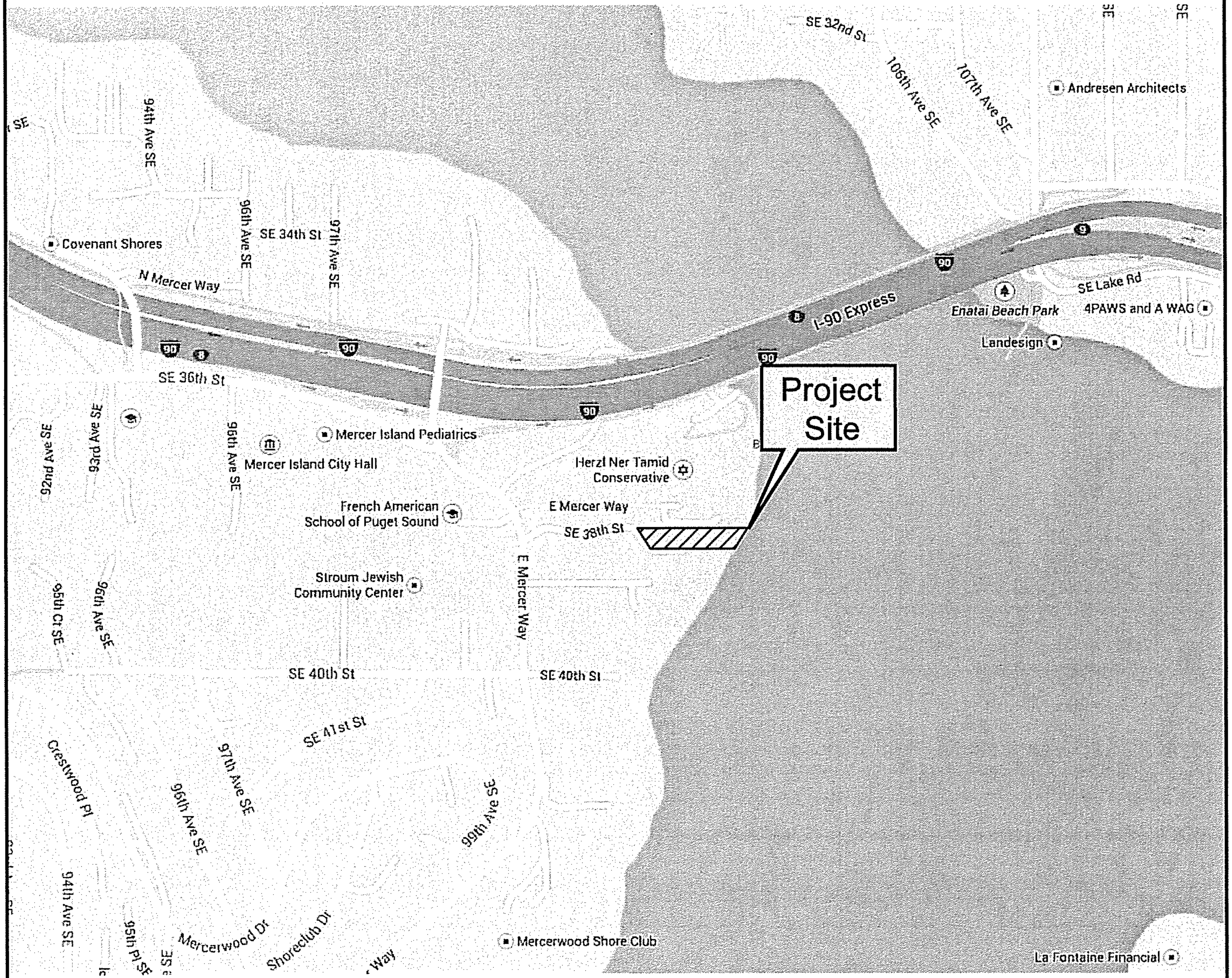
Nine Figures Attached

LSB:KMS:kmn

VICINITY MAP

Not to Scale



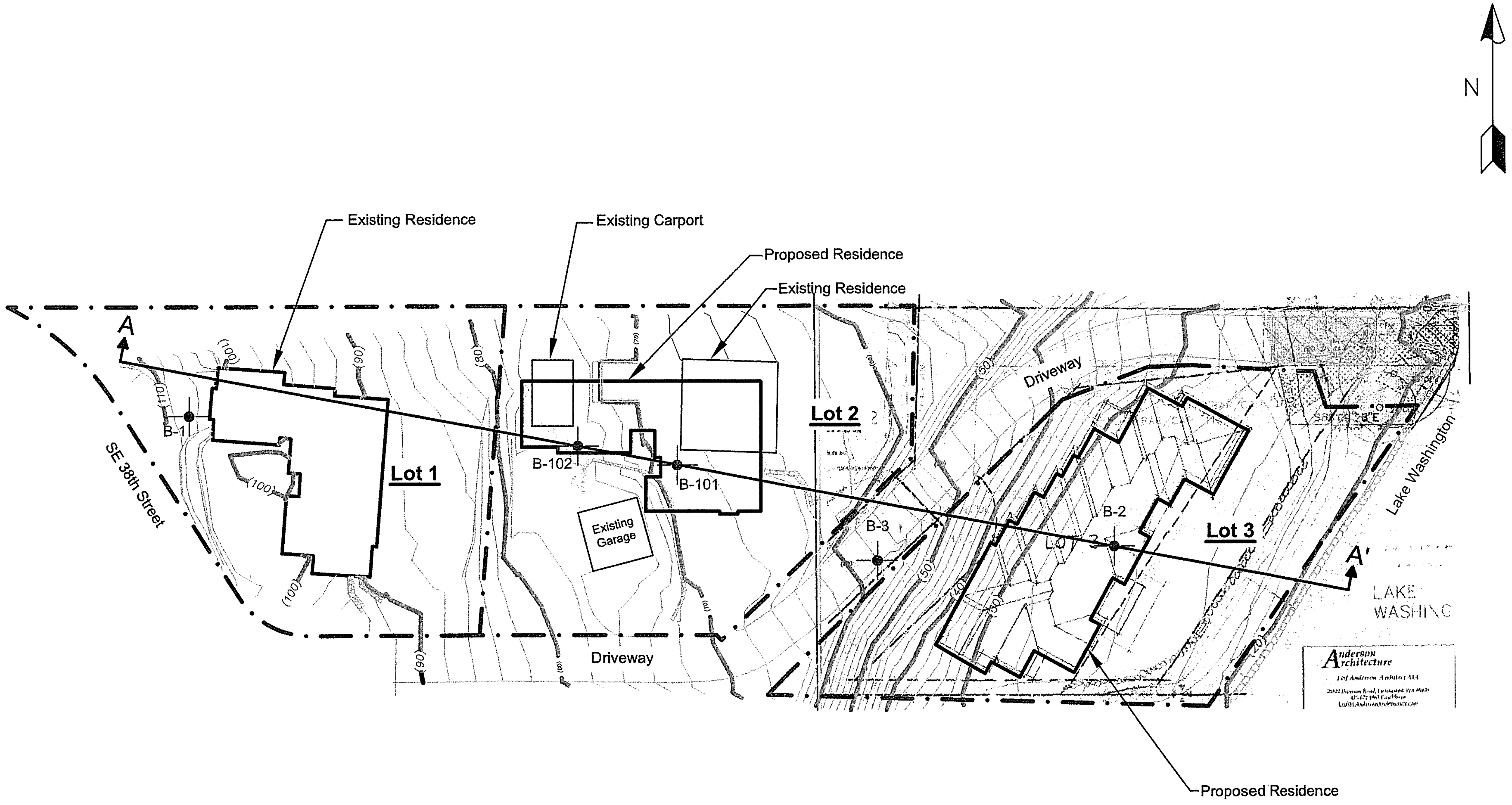


Mercer Island, WA

Project Number 891814	Gibson Short Plat Vicinity Map	NELSON GEOTECHNICAL ASSOCIATES, INC. NGA GEOTECHNICAL ENGINEERS & GEOLOGISTS 17311-135th Ave. NE. A-500 Woodinville. WA 98072 (425) 486-1669 / Fax 481-2510 Snohomish County (425) 339-1669 Wenatchee/Chelan (509) 665-7696 www.nelsongeotech.com	No.	Date	Revision	By	CK
Figure 1			1	3/27/14	Original	DPN	LSB

NGA Drafting 2014\891814 Gibson\VM.dwg

NGA Drafting 2014\891814 Gibson\SP.dwg



LEGEND

— · — Property line

B-1 —●— Number and approximate location of previous boring (May 20 and 25, 2005)

B-101 —●— Number and approximate location of recent boring (March 21, 2014)

A ↑___↑ A' Approximate location of cross-section

0 40 80

Scale: 1 inch = 40 feet

Reference: Site Plan based on a plan dated February 27, 2014, titled "A Custom Residence for On The Rock 98040, LLC," prepared by Anderson Architecture.

No.	Date	Revision	By	CK
1	3/26/14	Original	DPN	LSB

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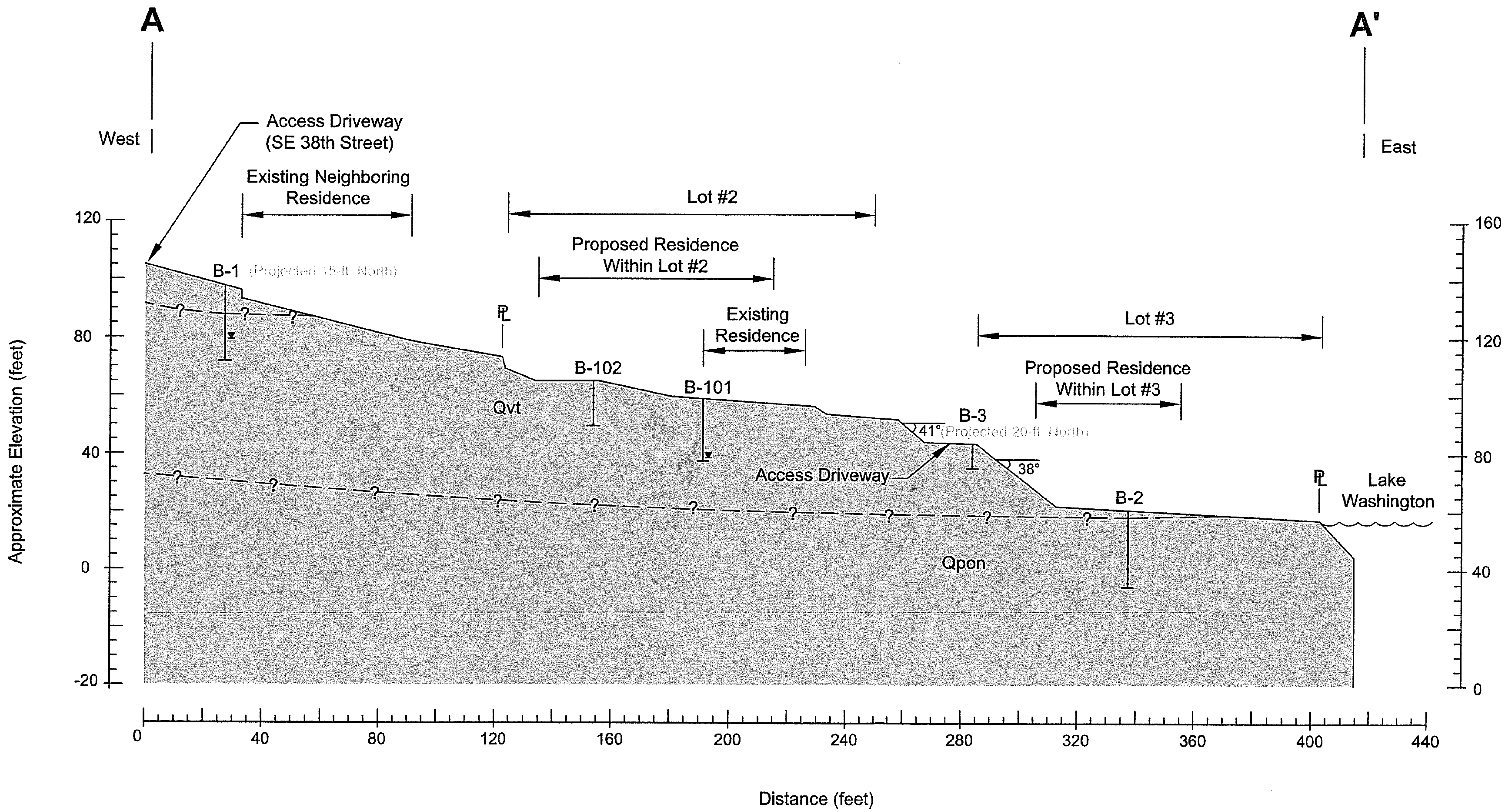
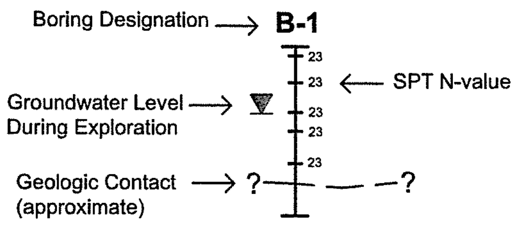
Gibson Short Plat
Site Plan

Project Number
891814

Figure 2



Exploration



NOTES:
1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are approximate.

Reference: Cross Section is based on field measurements using a hand-held clinometer and 100-ft tape measure.

No.	Date	Revision	By	CK
1	3/25/14	Original	LSB	KMS

NGA
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Gibson Short Plat
Cross-Section A-A'

Project Number
891814

Figure 3

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE - GRAINED SOILS MORE THAN 50 % RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE - GRAINED SOILS MORE THAN 50 % PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50 %	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 % OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FLAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-93.

2) Soil classification using laboratory tests is based on ASTM D 2488-93.

3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water.

Wet - Visible free water or saturated, usually soil is obtained from below water table

Project Number
891814

Figure 4

Gibson Short Plat
Soil Classification Chart

NGA
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GEOTECHNICAL ENGINEERS & GEOLOGISTS

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1	3/27/14	Original	DPN	LSB

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BORING LOG

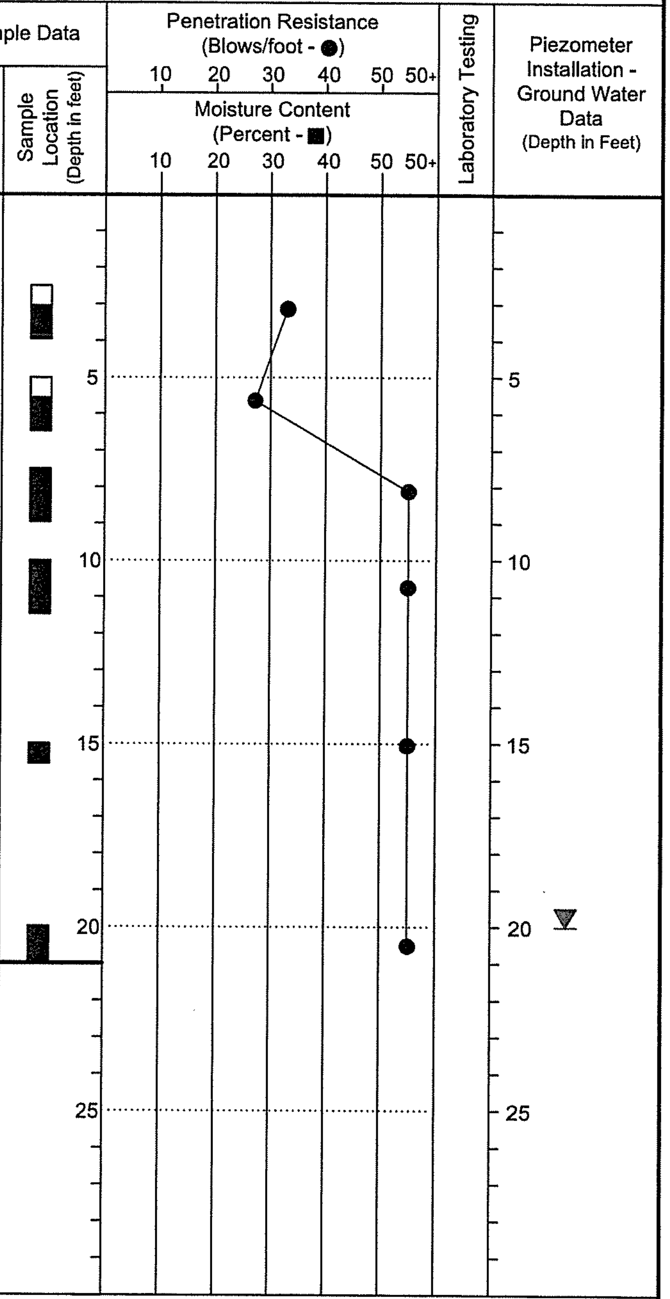
B-101

Logged by: LSB on 3/21/2014

Approximate Ground Surface Elevation: ~69 ft.

Description	Group Symbol	Blow Count
Brown-gray, silty fine to medium sand with gravel (dense, moist) (weathered till)	SM	32
Brown-gray, silty fine to medium sand with trace gravel (medium dense, moist) (unweathered till)	SM	28
-becomes very dense		60
		81
		50-6"
Brown-gray, fine to medium sand with silt and gravel (very dense, wet)	SP-SM	
Gray silt with trace fine sand (hard, moist)	ML	50-6"

Boring terminated below existing grade at 21.0 feet on 3/21/14. Minor groundwater seepage was encountered at 20.0 feet during drilling.



LEGEND

- Depth Driven and Amount Recovered with 2-inch O.D. Split-Spoon Sampler
- Depth Driven and Amount Recovered with 3-inch Shelby Tube Sampler
- ☐ Solid PVC Pipe
- ⊟ Slotted PVC Pipe
- ▬ Monument/ Cap to Piezometer
- * Liquid Limit
- \+ Plastic Limit
- ▨ Concrete
- Bentonite
- ▨ Native Soil
- ▨ Silica Sand
- ▼ Water Level

M	Moisture Content
A	Atterberg Limits
G	Grain-size Analysis
DS	Direct Shear
PP	Pocket Penetrometer Readings, tons/ft
P	Sample Pushed
T	Triaxial

NOTE: Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

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Gibson Short Plat
Boring Log

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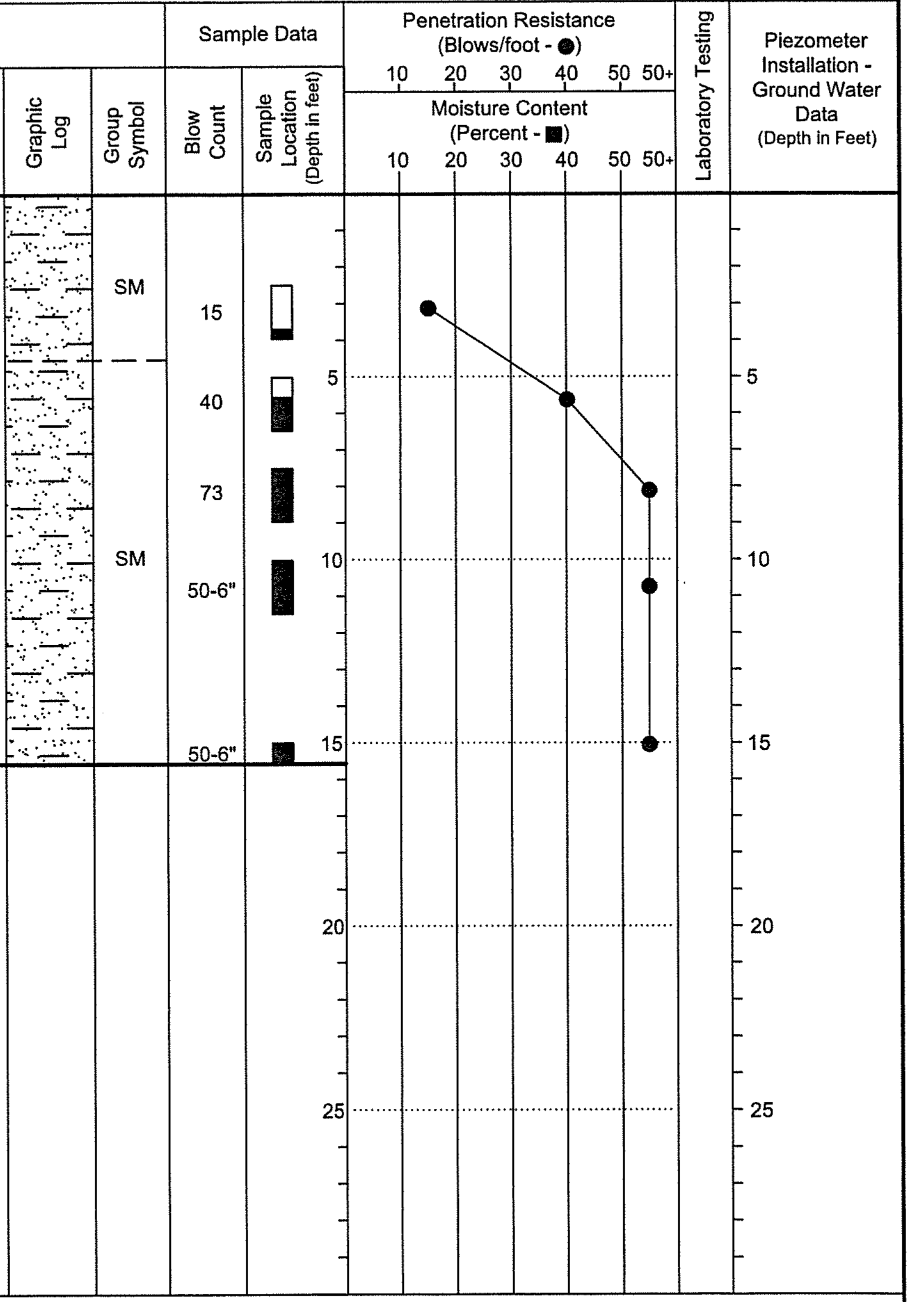
Logged by: LSB on 3/21/2014

BORING LOG

B-102

Approximate Ground Surface Elevation: ~76 ft.

Soil Profile: Description	Group Symbol	Sample Data: Blow Count
Dark brown, silty fine to medium sand with gravel and organics (medium dense, moist)	SM	15
Gray, silty fine to medium sand with trace gravel (medium dense, moist) (unweathered till)	SM	40
-becomes very dense		73
		50-6"
		50-6"
Boring terminated below existing grade at 15.5 feet on 3/21/14. Groundwater seepage was not encountered during drilling.		



LEGEND

▭ Depth Driven and Amount Recovered with 2-inch O.D. Split-Spoon Sampler

■ Depth Driven and Amount Recovered with 3-inch Shelby Tube Sampler

☐ Solid PVC Pipe

⊟ Slotted PVC Pipe

▬ Monument/ Cap to Piezometer

* Liquid Limit

\+ Plastic Limit

▨ Concrete

Bentonite

▨ Native Soil

▨ Silica Sand

▼ Water Level

M	Moisture Content
A	Atterberg Limits
G	Grain-size Analysis
DS	Direct Shear
PP	Pocket Penetrometer Readings, tons/ft
P	Sample Pushed
T	Triaxial

NOTE: Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

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Gibson Short Plat
Boring Log

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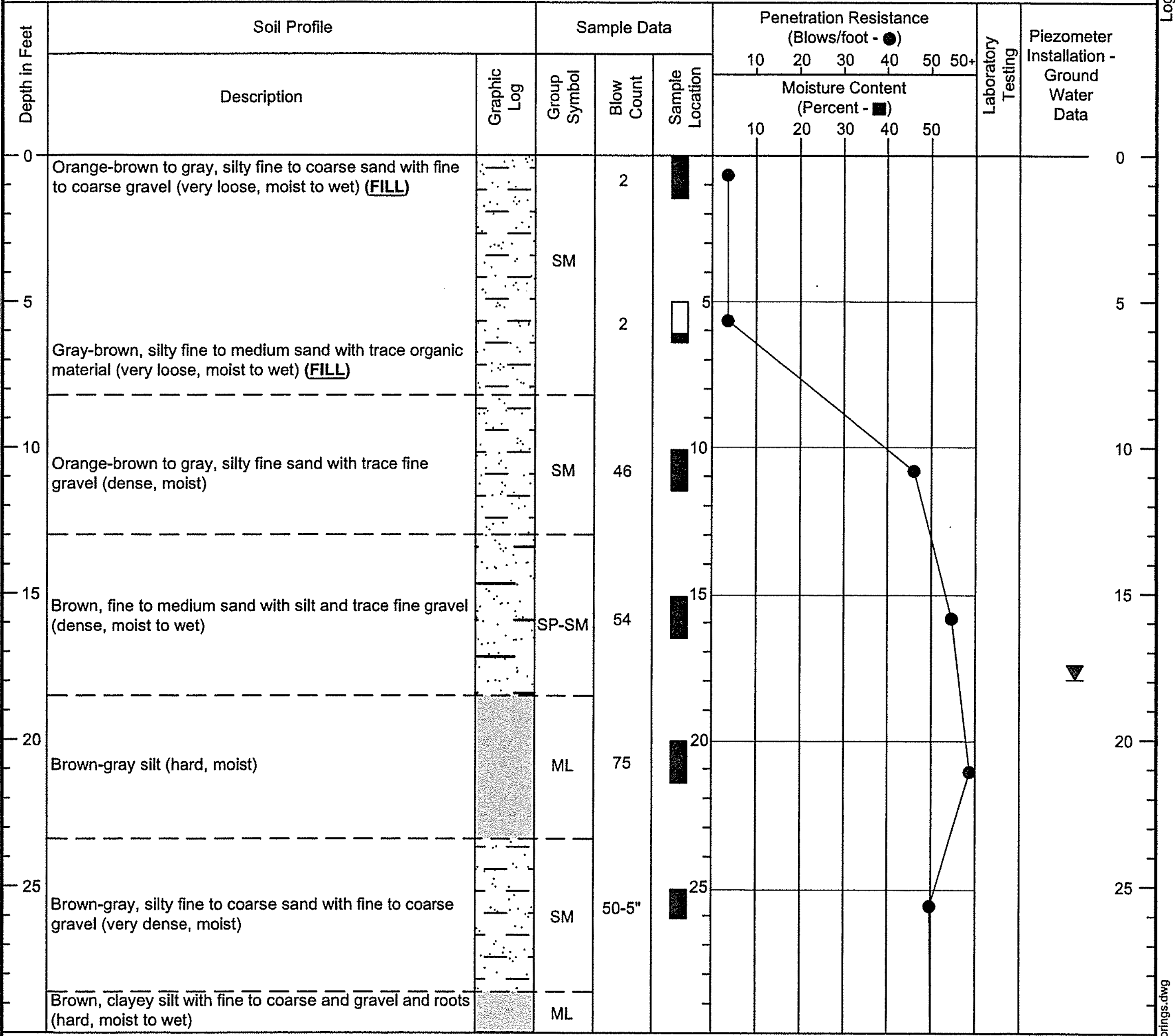
Boring B-1

Logged by: CAM on 5/20/04

Approximate Ground Surface Elevation: 105 ft.

Soil Profile – Description	Group Symbol	Blow Count
Orange-brown to gray, silty fine to coarse sand with fine to coarse gravel (very loose, moist to wet) (**FILL**)	SM	2
Gray-brown, silty fine to medium sand with trace organic material (very loose, moist to wet) (**FILL**)		2
Orange-brown to gray, silty fine sand with trace fine gravel (dense, moist)	SM	46
Brown, fine to medium sand with silt and trace fine gravel (dense, moist to wet)	SP-SM	54
Brown-gray silt (hard, moist)	ML	75
Brown-gray, silty fine to coarse sand with fine to coarse gravel (very dense, moist)	SM	50-5"
Brown, clayey silt with fine to coarse and gravel and roots (hard, moist to wet)	ML	



LEGEND

- Depth Driven and Amount Recovered with 2-inch O.D. Split-Spoon Sampler
- * Liquid Limit
- \+ Plastic Limit
- Solid PVC Pipe
- Slotted PVC Pipe
- Monument/ Cap to Piezometer
- Concrete
- Bentonite
- Native Soil
- Silica Sand
- ▼ Water Level

M	Moisture Content Lab Test
G	Grain-size Analysis
TV	Torvane Reading, tons/ft
PP	Pocket Penetrometer Reading, tons/ft
P	Sample Pushed

NOTE: The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.

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Gibson Short Plat
Previous Boring Log

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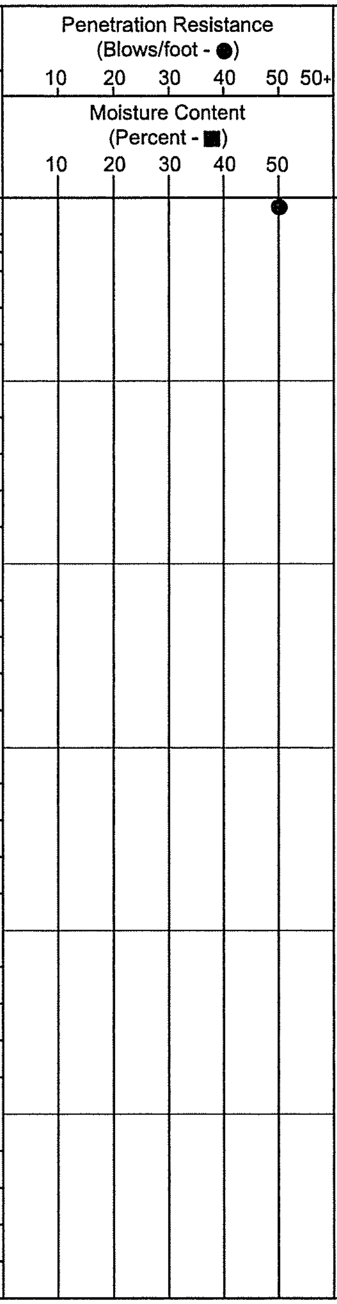
Boring B-1
(cont.)

Logged by: CAM on 5/20/05

Depth in Feet	Soil Profile – Description	Graphic Log	Group Symbol	Blow Count	Sample Location	Laboratory Testing	Piezometer Installation - Ground Water Data
30	Brown, clayey silt with fine to coarse gravel and roots (hard, moist to wet)	▨	ML	50-5"	■		
	Boring was completed at 31.5 feet on 5/20/2005. Groundwater was encountered at 18.0 feet during drilling.						



LEGEND

- Depth Driven and Amount Recovered with 2-inch O.D. Split-Spoon Sampler
- * Liquid Limit
- \+ Plastic Limit
- Solid PVC Pipe
- Slotted PVC Pipe
- Monument/ Cap to Piezometer
- Concrete
- Bentonite
- Native Soil
- Silica Sand
- ▼ Water Level

M Moisture Content Lab Test
G Grain-size Analysis
TV Torvane Reading, tons/ft
PP Pocket Penetrometer Reading, tons/ft
P Sample Pushed

NOTE: The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.

Project Number							
891814	Gibson Short Plat Previous Boring Log	NELSON GEOTECHNICAL ASSOCIATES, INC. GEOTECHNICAL ENGINEERS & GEOLOGISTS	No.	Date	Revision	By	CK
Figure 7			1	3/27/14	Original	LSB	KMS
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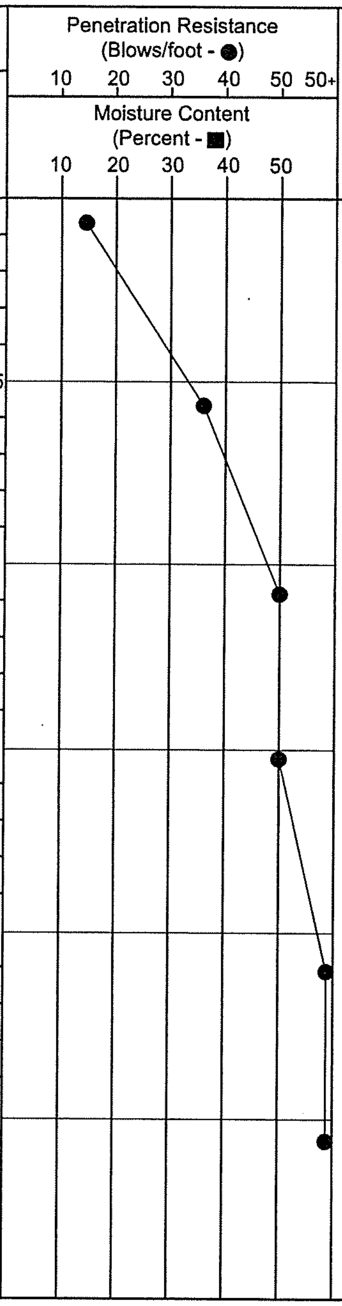
Boring B-2

Logged by: CAM on 5/20/04

Approximate Ground Surface Elevation: 22 ft.

Soil Profile	Sample Data	
Description	Group Symbol	Blow Count
Topsoil		
Light brown, fine to coarse sand with silt and fine to coarse gravel (medium dense, moist)	SP-SM	14
Gray, iron-oxide stained silt interbedded with fine sand with silt and fine gravel (hard/dense, moist)	ML/ SP-SM	36
Gray, iron-oxide stained silt (hard, moist)	ML	50-6"
Gray silt with fine sand (hard, moist)	ML	50-4"
Gray silt (hard, moist)	ML	70
Gray, silt interbedded with fine sand (hard/very dense, moist)	ML/SP	60

Boring was completed at 26.5 feet on 5/20/2005.
Groundwater was not encountered during drilling.



Laboratory Testing

Piezometer Installation - Ground Water Data

0 5 10 15 20 25

LEGEND

- Depth Driven and Amount Recovered with 2-inch O.D. Split-Spoon Sampler
- * Liquid Limit
- \+ Plastic Limit
- Solid PVC Pipe
- Slotted PVC Pipe
- Monument/ Cap to Piezometer
- Concrete
- Bentonite
- Native Soil
- Silica Sand
- ▼ Water Level

M	Moisture Content Lab Test
G	Grain-size Analysis
TV	Torvane Reading, tons/ft
PP	Pocket Penetrometer Reading, tons/ft
P	Sample Pushed

NOTE: The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.

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Gibson Short Plat
Previous Boring Log

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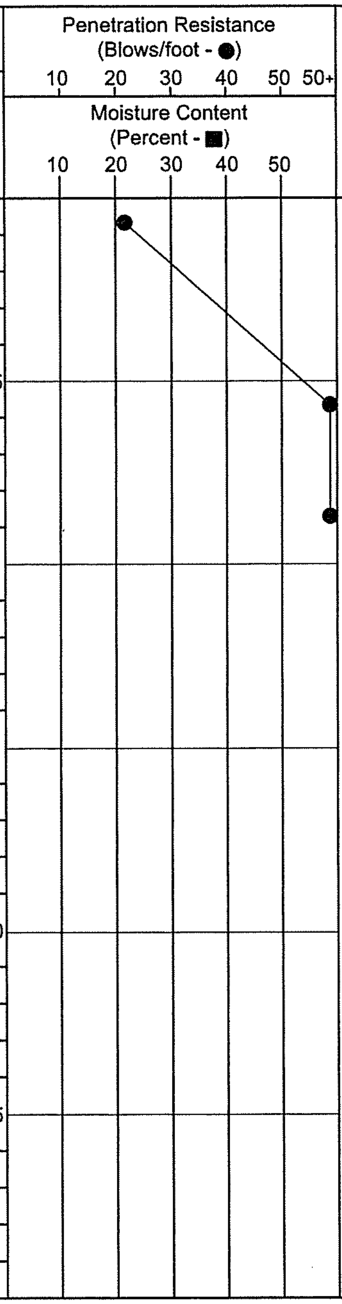
Boring B-3

Logged by: CAM on 5/25/04

Approximate Ground Surface Elevation: 55 ft.

Depth in Feet	Soil Profile: Description	Graphic Log	Sample Data: Group Symbol	Blow Count	Sample Location	Laboratory Testing	Piezometer Installation - Ground Water Data
0	Topsoil	▨		21	■		
	Gray, silty fine to coarse sand with fine to coarse gravel (medium dense, moist)		SM				
5	- becomes very dense			50-3.5"	■		
	- with iron-oxide staining			50-6"	■		
	Boring was completed at 9.0 feet on 5/25/2005. Groundwater was not encountered during drilling.						



LEGEND

- ■ Depth Driven and Amount Recovered with 2-inch O.D. Split-Spoon Sampler
- * Liquid Limit
- + Plastic Limit
- ☐ Solid PVC Pipe
- ⊟ Slotted PVC Pipe
- ▨ Monument/ Cap to Piezometer
- ▩ Concrete
- Bentonite
- ▨ Native Soil
- ▩ Silica Sand
- ▼ Water Level
- M Moisture Content Lab Test
- G Grain-size Analysis
- TV Torvane Reading, tons/ft
- PP Pocket Penetrometer Reading, tons/ft
- P Sample Pushed

NOTE: The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.

Project Number 891414	Gibson Short Plat Previous Boring Log	NELSON GEOTECHNICAL ASSOCIATES, INC. GEOTECHNICAL ENGINEERS & GEOLOGISTS
Figure 9		17311-135th Ave. NE. A-500 Woodinville, WA 98072 (425) 486-1669 / Fax 481-2510
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No.	Date	Revision	By	CK
1	3/27/14	Original	LSB	KMS

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APPENDIX C

Earth Consultants Inc.
Geotechnical Engineers, Geologists & Environmental Scientists

PREPARED FOR
THE DRAFTING CONNECTION

James Hatch

James Hatch
Staff Geologist

Robert S Levinson

Robert S. Levinson, P. E.
President

ROBERT S. LEVINSON
STATE OF WASHINGTON
14691
REGISTERED PROFESSIONAL ENGINEER

GEOTECHNICAL ENGINEERING STUDY
PROPOSED SINGLE-FAMILY RESIDENCE
LOT 9, DOYLE-HANSON ADDITION
MERCER ISLAND, WASHINGTON

E-4360

May 5, 1989

Earth Consultants, Inc.
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222 E. 26th Street, Suite 103
Tacoma, Washington 98411-9998
(206) 272-6608

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OCT 31 1989
DEPARTMENT OF
COMMUNITY DEVELOPMENT

Earth Consultants Inc.
Geotechnical Engineers, Geologists & Environmental Scientists

May 5, 1989 E-4360

The Drafting Connection
2100 - 124th Avenue Northeast
Mercer Island, Washington 98005

Attention: Mr. Kevin Scott

Gentlemen:

We are pleased to submit herewith our report titled "Geotechnical Engineering Study, Proposed Single-family Residence, Lot 9, Doyle-Hanson Addition, Mercer Island, Washington."

This report presents the results of our field exploration, selective laboratory tests, and engineering analyses. The purpose and scope of our study was outlined in our March 22, 1989 proposal.

Our study indicates that the west portion of the site is generally underlain by dense to very dense silty sand with gravel. The soils become partially cemented at three to four feet below the existing grade. In the east portion of the site, adjacent to Lake Washington, there is approximately three to four feet of loose to medium dense fill underlain by the dense to very dense silty sand. The fill was used to raise the grade of the lawn area behind the existing bulkhead wall.

Based on the encountered conditions, and the results of our analyses, we believe the proposed building can be supported on conventional spread and continuous footings bearing on the dense native soil or recompacted existing fill, or on new structural fill, depending upon encountered conditions and final grades. Pavements and floor slabs may be similarly supported.

These recommendations, along with other geotechnically-related aspects of the project, are discussed in more detail in the text of the attached report.

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222 E. 26th Street, Suite 101, Tacoma, Washington 98411-9998
Bellevue (206) 643-3780 Seattle (206) 464-1584 FAX (206) 746-0860 Tacoma (206) 272-6608

We appreciate this opportunity to have been of service to you during this initial phase of project development, and we look forward to working with you in the future phases as the project comes to fruition. In the meantime, should you or your consultants have any questions about the contents of this report, or if we can be of further assistance, please call.

Very truly yours,

EARTH CONSULTANTS, INC.

Robert S Levinson

Robert S. Levinson P. E.
President

JH/RSL/kml

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ILLUSTRATIONS

E-4360

GEOTECHNICAL ENGINEERING STUDY
PROPOSED SINGLE-FAMILY RESIDENCE
MERCER ISLAND, WASHINGTON

E-4360

INTRODUCTION

Project Description

The subject site is located immediately east of 3804 East Mercer Way in Mercer Island, Washington, approximately as indicated on the Vicinity Map, Plate 1. The purpose of this study was to explore the existing subsurface conditions at the site and, on this basis, to develop geotechnical recommendations for the proposed site development.

At the time our study was performed, the site and our exploratory locations were approximately as shown on the Test Pit Location Plan, Plate 2.

From our discussions, we understand you intend to construct a two-story, wood-frame, single-family residence with crawl-space floors. The building will be constructed with the back-slope stem-walls acting as retaining walls. We understand that maximum height for these walls will be eight feet.

From our discussions, we understand that the proposed building will be constructed at or near the existing grade. With the exception of retaining wall backfill, we do not anticipate that significant amounts of structural fill will be required for site development. Cuts on the order of eight feet will be required to prepare the site for construction.

Based on our experience with similar structures, we anticipate maximum total dead plus live loads will be as follows:

- Wall loads - 3 kips per lineal foot
- Column loads - 10 to 20 kips

If any of the above design criteria differ from those assumed above we should be consulted to revi ew the recommendations contained in this report. In any case, we recommend that Earth Consultants, Inc. (ECI) be retained to perform a general review of the final design.

Scope of Services

We performed this study in general accordance with the scope of services outlined in our March 22, 1989 proposal. On this basis, our report addresses:

- subsurface soil and groundwater conditions;
- suitability of existing on-site materials for use as fill, or recommendations for imported fill materials;
- site preparation, grading and earthwork procedures, including details of fill placement and compaction;
- short-term and long-term groundwater management and erosion control measures;
- foundation support parameters, including bearing capacity and resistance to lateral loads for conventional foundations;
- retaining wall design criteria;
- estimates of potential total and differential settlement magnitudes; and
- parking area and access roadway pavement sections.

This report has been prepared for specific application to this project in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area for the exclusive use of The Drafting Connection and their representatives. No other warranty, expressed or implied, is made. We recommend that this report, in its entirety, be included in the project contract documents for the information of the contractor.

SITE CONDITIONS

Surface

The subject site is located immediately east of 3804 East Mercer Way and west of Lake Washington in Mercer Island, Washington (see Plate 1, Vicinity Map). The property is roughly rectangular and is bounded to the west, north and south by lots developed with single-family residences, and to the east by Lake Washington.

The west portion of the site slopes up to the west at an inclination of approximately 3:1 (Horizontal:Vertical). The slope breaks near the center of the site and is generally flat to the east with a very slight slope from west to east. Total relief is approximately thirty (30) feet across the site. The lot is currently undeveloped and has been in use as a lawn and recreation area. Vegetation on the site is composed of lawn grasses with locally heavy blackberry bushes along the access road.

Subsurface

The site was explored by excavating four test pits at the approximate locations shown on Plate 2. Please refer to the Test Pit Logs, Plates 4 through 5, for a more detailed description of the conditions encountered at each location explored. Descriptions of the field exploration methods and laboratory testing program are included in the appendices to this report. The following is a generalized description of the subsurface conditions encountered.

The exploratory test pits encountered three to six inches of organic-laden silty topsoil and sod and, in Test Pits TP-2 and TP-3, approximately four feet of loose to medium dense gravelly fine sand fill. The surficial organic and fill soils are underlain by native, dense to very dense silty sand (SM) with varying amounts of gravel. These dense to very dense soils are suitable for bearing provided they are recompacted after excavation as discussed in the Site Preparation and Earthwork section of this report.

Silty sand containing varying amounts of gravel extended to the depth of our exploration at seven feet below existing grade. These lower materials were partially cemented in-place and became very dense with increasing depth. Typically, they are referred to as glacial till or sometimes "hardpan". These soils are suitable for use as structural fill, however, because of their relatively high silt content they are highly moisture-sensitive.

Groundwater

A relatively well-established groundwater level was observed in the south portion of the site at approximately one foot below the existing grade The seepage appears to descend from the slope to the west and tends to flow along the surface of the more dense and cemented layers as a "perched" water level. A slight swale in the central portion of the lawn area was saturated to approximately one foot below the existing grade. This water appears to be coming from a drain-tile drain line which is part of an upslope interceptor drain system for the existing single-family residence to the west. This water will need to be controlled prior to the start of construction. Please see the Site Drainage section of this report.

The groundwater and seepage levels are not static. One may expect fluctuations in the levels depending on the season, amount of rainfall, surface water runoff, and other factors. Generally, the water level is higher in the wetter winter months.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our study, it is our opinion that the site can be developed generally as planned provided the recommendations contained in this report are incorporated into the final site development plans.

The proposed building can be supported on conventional continuous and spread footings bearing on recompacted existing loose to medium dense gravelly sand fill, newly-placed structural fill, or on the native, dense to very dense silty sand till. The loose to medium dense fill soils will require recompaction in accordance with the recommendations contained in this report in order to provide a stable bearing surface. Pavements and floor slabs can be supported on at least one foot of recompacted native soil or on structural fill, as desired, depending upon final grade and encountered soil conditions.

The moisture-sensitive, native,dense to very dense soils were generally near the optimum moisture content at the time of our field exploration. They can be used as structural fill during dry weather. However, because they contain a significant amount of fines they will become difficult, if not impossible, to work or compact if the soil moisture content is above the optimum moisture content. If this should occur, the moisture content may be reduced through aeration in dry weather or by adding lime or cement powder to absorb excess soil moisture.

Water discharged from the interceptor drain upslope will need to be controlled prior to the start of the construction sequence. It should be tightlined out to the shore of Lake Washington. Footing drains and downspouts may be connected to this tightline.

These and other geotechnically-related aspects of the project are discussed in more detail in the following sections of the report.

Site Preparation and General Earthwork

The building and pavement areas should be stripped and cleared of all trees, surface vegetation, organic matter, existing utilities, and any other deleterious material. Based on the information from our test pit logs, we estimate that an average stripping depth of six inches will be required. The stripping depth may be somewhat deeper in the small swale in the central portion of the site due to its high moisture content. Stripped materials should be removed from the site and disposed, or "lost" in landscaped areas, as desired. The stripped material should not be mixed with any materials to be used as structural fill.

Following the stripping operation, the ground surface where structural fill, foundations, pavements or slabs are to be placed should be proofrolled. All proofrolling should be performed under the full-time observation of ECI's representative. This procedure, which should be accomplished with a suitable steel-wheel roller, is to help determine the presence and approximate areal extent of any soft or unstable areas. Any such soft or unstable areas should be moisture-conditioned, as appropriate, and recompacted.

If after recompaction these areas remain soft or unstable, they should be overexcavated and the unsuitable materials removed and disposed. The overexcavation should be backfilled with compacted structural fill or crushed rock to a depth that will provide a stable base. Typically, a depth of two to three feet is adequate for this purpose.

Alternatively, depending on the degree of softness or instability, you may overlay the surface with approximately six (6) to twelve (12) inches of coarse crushed rock (quarry spalls or railroad ballast). This material should be firmly tamped into the subgrade with a roller to tighten it sufficiently to conduct additional construction activities.

In addition to the general proofrolling of building and pavement areas, we recommend you carefully densify the excavated foundation subgrades.

Ideally, but particularly during wet weather, structural fill should comprise a free-draining, granular, organic-free material with a maximum size of three inches. It should contain less than 5 percent fines (silt and clay-size particles passing the No. 200 mesh sieve). During dry weather, any compactible non-organic soil meeting the above maximum size criterion, including the on-site soils, may be used as structural fill.

With the exception of the surficial soil in the swale, the on-site soils were near their optimum moisture content and, if desired, may be used as structural fill provided the grading opperations are conducted during dry weather. However, the native, silty sand till soil contains a significant amount of fines and should be considered moisture-sensitive. Thus, compaction and grading will be difficult if the soil moisture increases above the optimum moisture content. Your earthwork contractor should be prepared for this.

Structural fill under floor slabs and footings should be placed in thin horizontal lifts not exceeding ten inches in loose thickness. Each lift should be compacted to at least 95 percent of maximum dry density, as determined by ASTM Test Designation D-1557-78 (Modified Proctor).

Fill under pavements and walks should be placed in similar thin horizontal lifts and, with the exception of the upper twelve (12) inches, be compacted to at least 90 percent of maximum density. The top twelve (12) inches should be compacted to at least 95 percent maximum density.

All fill material should be placed at or near the optimum moisture content. If the materials are too wet to be compacted to the required degree, it will be necessary to dry them or replace them with a more granular material. Drying can be achieved by aeration or by intermixing lime or cement powder to absorb excess moisture.

Foundations

Based on the encountered site soil conditions and the preliminary building design criteria, it is our opinion the proposed building can be supported on conventional spread and continuous footings. The footings should bear on recompacted existing fill soils, dense to very dense native till soil or on structural fill, depending upon final grade and encountered soil conditions. As previously mentioned, loose to medium dense fill soils will require recompaction as described in the Site Preparation and Earthwork section of this report.

We recommend the following parameters be used in foundation design:

- Allowable soil-bearing pressure including all dead and live loads. = 2000 psf
- Minimum depth of perimeter footing; below adjacent final exterior grade. = 18 inches
- Minimum depth of interior footings; below top of floor slab. = 12 inches
- Minimum width of wall footings = 18 inches
- Estimated post-construction settlement = 1 inch, or less
- Estimated post-construction differential settlement; across building width = 1/2 inch
- Estimated rate of settlement = Approximately 90 percent during construction, remainder over following six months.

A one-third increase in the above allowable bearing pressures can be used when considering short-term transitory wind or seismic loads.

Lateral loads can also be resisted by friction between the foundation and the supporting compacted subgrade or by passive earth pressure acting on the buried portions of the foundations. For the latter, the foundations must be poured "neat" against the existing soil or backfilled with a compacted fill meeting the requirements of structural fill:

- Passive pressure = 300 pcf equivalent fluid weight
- Coefficient of friction = 0.35

As a precautionary measure, we recommend drains be placed around all perimeter footings. More specific details of perimeter foundation drains are provided in the Site Drainage section of this report.

Retaining Walls

We understand the proposed single-family residence may be constructed with partially buried stemwalls acting as retaining walls in the upslope portion. They will have a maximum height of eight feet. We recommend the following values be used in retaining wall design:

- For walls that can rotate distance equal to 0.0002 times the wall height = 35 pcf equivalent fluid weight
- For walls fixed against rotation = 60 pcf equivalent fluid weight

These values assume a horizontal backfill and that vehicular, construction, floor, or surcharge loads will not act on the wall. If such surcharges are to apply, they should be added to the above design lateral pressures.

We assume that the walls will be backfilled with a suitable free-draining material. Typically, wall backfill should consist of materials similar to structural fill. Wall backfill should have a maximum size of three inches, be organic free, and have a maximum of three percent fines (materials passing the No. 200 mesh sieve). Twenty-five (25) to seventy (70) percent of the particles should pass the No. 4 mesh sieve.

As an alternative to free-draining wall backfill, you may wish to consider the use of a geotextile drainage product such as "Miradrain". In either case, we recommend the installation of a drain line aling the base of each wall. These drains are discussed in more detail in the Site Drainage section of this report.

Slab-on-Grade Floors

Slab-on-grade floors can be supported on recompacted existing fill soils, on the dense to very dense till soil, or structural fill, depending upon encountered conditions and final grades. Any fill or native soil loosened or disturbed by construction activity should either be recompacted or excavated and replaced with compacted structural fill or crushed rock.

To allow for moisture build-up on the subgrade, the slab should be provided with a capillary break consisting of a minimum of four inches of free-draining sand and gravel. We also recommend that a vapor barrier, such as a 6-mil plastic membrane, be placed over the capillary break beneath the slab to reduce both water vapor transmission through the slab and the resultant moisture related damage to interior furnishings.

Two to four inches of damp sand may be placed over the membrane for protection during construction, to aid in curing of the concrete, and to help prevent cement paste bleeding down into the underlying capillary break through joints or tears in the vapor barrier.

Excavations and Slopes

With the exception of the back-slope retaining walls, major excavations or slope construction efforts are not anticipated for this project. You should be aware that in no case should excavation slopes, including utility trenches, be greater than the limits specified in local, state and national government safety regulations.

Temporary cuts greater than four feet in height should be sloped at an inclination no steeper than 1H:1V. If slopes of this inclination, or flatter, cannot be constructed, or if excavations greater than four feet in depth are required, temporary shoring may be necessary. This shoring will help protect against slope or excavation collapse, and will provide protection to workmen in the excavation. If temporary shoring is required, we will be available to provide geotechnical shoring design criteria, if requested.

All permanent cut and fill slopes should be inclined no steeper than 3:2 (Horizontal:Vertical) and 2H:1V. These recommendations are applicable to slopes with a maximum height of ten feet. If higher slopes are anticipated, we should be contacted for the appropriate design and construction criteria.

We also recommend that all excavated slopes be examined at the time of construction by ECI's representative to verify that conditions are as anticipated. Supplementary recommendations can then be developed, if necessary, to enhance stability. Such measures can include, but may not be limited to, flattening of slopes or installation of surface or subsurface drains. In any case, water should not be allowed to flow uncontrolled over the top of any slopes.

All permanently exposed slopes should be seeded with an appropriate species of deep-rooted, rapid growth vegetation to reduce erosion potential and improve stability of the surficial layer of soil.

Site Drainage

Light groundwater seepage was observed at approximately one foot below the existing grade in the south portion of the site. We anticipate that the soil in the small swale in the central portion of the site will be saturated to a depth of approximately one foot below the existing grade. It is our opinion that the majority of this water is emanating from an existing interceptor drain upslope. After this drain has been tight-lined to the lake, we do not expect the site groundwater levels to present any major construction related problems. However, the tight-line should be installed early in the construction sequence to prevent potential saturation of the exposed subgrades

The buried portion of the interceptor drain appears to be installed upslope of the existing single-family residence to the west of the subject project. The drain carries collected water around the existing house and runs east and downslope, discharging immediately upslope of the east property line. The water then descends the surface of the slope with the majority being captured by the existing small swale. The drain consists of ceramic drain-tile laid end to end and is probably bedded in pea gravel. It is our opinion that the drain-tile should be removed and replaced with a PVC tight-line near the downslope side of the existing house. Stub-outs may be constructed in the tight-line in the area of the proposed house for downspout lines and footing drains. The tight-line should extend out past the bulkhead wall and discharge into the lake. The tight-line must be provided with a non-erosive discharge area. A small concrete or brick pad on the shore should be adequate for this purpose.

Your contractor should be aware that the City of Mercer Island will require installation of a temporary siltation fence during the construction period. The siltation fence will inhibit silt-laden surface run-off during rainy periods. We suggest that the fence be installed inside of the existing bulkhead wall.

The site should be graded such that surface water is directed off the site. Water should not be allowed to stand in any area where buildings, slabs or pavements are to be constructed. During construction, loose surfaces should be sealed at night by compacting the surface to reduce the potential for moisture infiltration into the soils. Final site grades should allow for drainage away from the building foundations. We suggest that the ground be sloped at a gradient of 3 percent for a distance of at least ten feet away from the buildings except in areas that are to be paved.

If seepage is encountered in foundation excavations during construction, we recommend your contractor slope the bottom of the excavation to one or more shallow sump pits. The collected water can then be pumped from these pits to a positive and permanent discharge, such as a nearby storm drain. Depending on the magnitude of such seepage, it may also be necessary to interconnect the shallow sump pits by a system of shallow connector trenches.

We recommend you install footing drains around the building perimeter, including the backslope retaining walls. These drains should consist of a four-inch minimum diameter perforated or slotted rigid drain pipe laid at, or just below, the invert of the footing with a gradient sufficient to initiate flow. The drain line should be bedded on, surrounded by, and covered with a free-draining washed rock, pea gravel, or other free-draining granular material.

Once the drains are installed, with the exception of the upper twelve (12) inches, the excavation can be backfilled with a granular fill material. The surficial twelve (12) inches of fill should consist of compacted and relatively impermeable soil. It can be separated from the underlying more granular drainage material by a layer of building paper or visqueen. The surface should be sloped to drain away from the building wall. Alternatively, the surface can be sealed with asphalt or concrete paving. A typical detail is provided on Plate 7. Under no circumstances should roof downspout drain lines be connected to the footing drain system. All roof downspouts must be separately tightlined to discharge. We recommend you install sufficient cleanouts at strategic locations to allow for periodic maintenance of the footing drain and downspout tightline systems.

We recommend the appropriate locations of subsurface drains, if needed, be established during grading operations by ECI's representative at which time the seepage areas, if present, may be more clearly defined.

Pavement Areas

The adequacy of site pavements is strictly related to the condition of the underlying subgrade. If this is inadequate, no matter what pavement section is constructed, settlement or movement of the subgrade will be reflected up through the paving. In order to avoid this situation, we recommend the subgrade be treated and prepared as described in the Site Preparation section of this report. This means at least the top twelve (12) inches of the subgrade should be compacted to 95 percent of the maximum dry density (per ASTM D-1557-78). It is possible that some localized areas of soft, wet or unstable subgrade may still exist after this process. If so, they may require overexcavation of the unsuitable materials and their replacement with a compacted structural fill or a crushed rock. Depending on the nature of the prepared subgrade at the time of construction, it may also be necessary to use a geotechnical fabric, such as Mirafi 500X, to separate pavement materials from the underlying subgrade and to help strengthen the pavement section.

We have provided you with two alternative pavement sections for the lightly trafficked access and parking areas:

- Two inches of Asphalt Concrete (AC) over four inches of Crushed Rock Base (CRB) material, or
- two inches of AC over three inches of Asphalt Treated Base (ATB) material.

LIMITATIONS

Our recommendations and conclusions are based on the site materials observed, selective laboratory testing and engineering analyses, and our experience and engineering judgement. The conclusions and recommendations are professional opinions derived in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty is expressed or implied.

The recommendations submitted in this report are based upon the data obtained from the test pits. Soil and groundwater conditions between test pits may vary from those encountered. The nature and extent of variations between our exploratory locations may not become evident until construction. If variations then appear, ECI should be requested to reevaluate the recommendations of this report and to modify or verify them in writing prior to proceeding with the construction.

Additional Services

We recommend that ECI be retained to perform a general review of the final design and specifications to verify that the earthwork and foundation recommendations have been properly interpreted and implemented in the design and in the construction specifications.

We also recommend that ECI be retained to provide geotechnical services during construction. This is to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction. Because of the nature of this project we do not accept responsibility for the performance of the foundation or earthwork unless we are retained to review the construction drawings and specifications, and to provide construction observation and testing services.

APPENDIX A
E-4360
FIELD EXPLORATION AND LABORATORY TESTING

Our field exploration was performed on March 29, 1989. Subsurface conditions at the site were explored by excavating four (4) test pits to a maximum depth of seven (7) feet below existing grade.

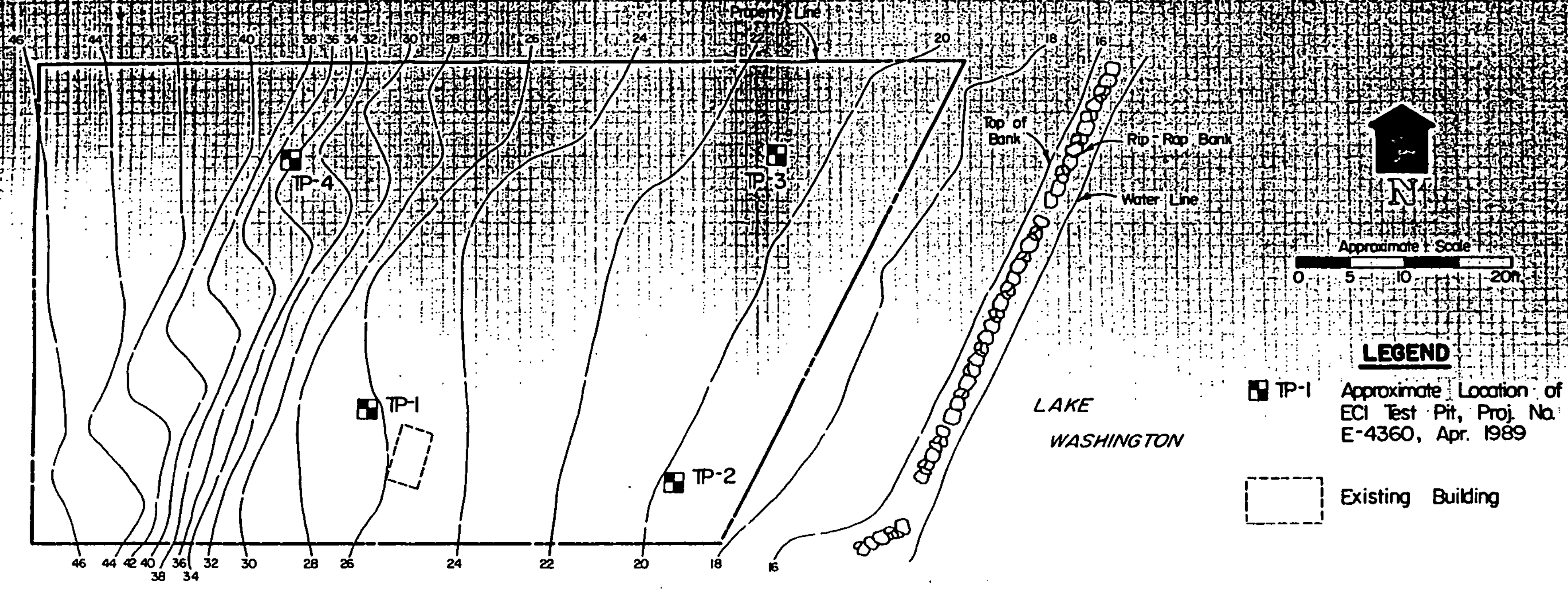
Approximate test pit locations were determined by measurement from property corners. Approximate test pit elevations were determined by interpolation between contour lines on a topographic survey and site plan by The Drafting Connection, undated. The locations and elevations of the test pits should be considered accurate only to the degree implied by the method used. These approximate locations are shown on the Test Pit Location Plan, Plate 2.

The field exploration was continuously monitored by a geologist from our firm who classified the soils encountered and maintained a log of each test pit, obtained representative samples, measured groundwater levels, and observed pertinent site features.

All samples were visually classified in accordance with the Unified Soil Classification System which is presented on Plate 3, Legend. The Test Pit Logs are presented on Plates 4 and 5. The final logs represent our interpretations of the field logs and the results of the laboratory examination and tests of field samples. The stratification lines on the logs represent the approximate boundaries between soil types. In actuality, the transitions may be more gradual.

The consistency of the soil was estimated based on the effort required to excavate the soil, the stability of the trench walls, and other factors.

Representative soil samples were placed in closed containers and returned to our laboratory for further examination and testing.



LEGEND

▣ TP-1	Approximate Location of ECI Test Pit, Proj. No. E-4360, Apr. 1989
⬚	Existing Building

Reference :
Topographic Survey
By Drafting Connection
Undated

Earth Consultants Inc.
Geotechnical Engineers, Geologists & Environmental Scientists

Test Pit Location Plan
Earthstone / Johnstone Building
Mercer Island, Washington

Proj No. 4360	**Drwn.** GLS	**Date** Apr. '89	**Checked** JH	**Date** 4/17/89	**Plate** 2

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTION
Coarse Grained Soils More Than 50% Material Larger Than No. 200 Sieve Size	Gravel And Gravelly Soils More Than 50% Coarse Fraction Retained On No. 4 Sieve	Clean Gravels (little or no fines)	░	GW gw	Well-Graded Gravels, Gravel-Sand Mixtures, Little Or No Fines
			░	GP gp	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little Or No Fines
		Gravels With Fines (appreciable amount of fines)	▥	GM gm	Silty Gravels, Gravel-Sand-Silt Mixtures
			▨	GC gc	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand And Sandy Soils More Than 50% Coarse Fraction Passing No. 4 Sieve	Clean Sand (little or no fines)	░	SW sw	Well-Graded Sands, Gravelly Sands, Little Or No Fines
			░	SP sp	Poorly-Graded Sands, Gravelly Sands, Little Or No Fines
		Sands With Fines (appreciable amount of fines)	▥	SM sm	Silty Sands, Sand-Silt Mixtures
			▨	SC sc	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils More Than 50% Material Smaller Than No. 200 Sieve Size	Silts And Clays	Liquid Limit Less Than 50	▥	ML ml	Inorganic Silts & Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands; Clayey Silts w/ Slight Plasticity
			▨	CL cl	Inorganic Clays Of Low To Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean
			▥	OL ol	Organic Silts And Organic Silty Clays Of Low Plasticity
	Silts And Clays	Liquid Limit Greater Than 50	▥	MH mh	Inorganic Silts, Micaceous Or Diatomaceous Fine Sand Or Silty Soils
			▨	CH ch	Inorganic Clays Of High Plasticity, Fat Clays
			▨	OH oh	Organic Clays Of Medium To High Plasticity, Organic Silts
Highly Organic Soils			░	PT pt	Peat, Humus, Swamp Soils With High Organic Contents

Topsoil	░	Humus And Duff Layer
Fill	▩	Highly Variable Constituents

The Discussion In The Text Of This Report Is Necessary For A Proper Understanding Of The Nature Of The Material Presented In The Attached Logs

Notes :
Dual symbols are used to indicate borderline soil classification. Upper case letter symbols designate sample classifications based upon laboratory testing; lower case letter symbols designate classifications not verified by laboratory testing.

I 2" O.D. SPLIT SPOON SAMPLER
Ⅱ 2.4" I.D. RING SAMPLER OR SHELBY TUBE SAMPLER
P SAMPLER PUSHED
✱ SAMPLE NOT RECOVERED
∇ WATER LEVEL (DATE)
▮ WATER OBSERVATION WELL

C TORVANE READING, tsf
qu PENETROMETER READING, tsf
W MOISTURE, percent of dry weight
pcf DRY DENSITY, pounds per cubic ft.
LL LIQUID LIMIT, percent
PI PLASTIC INDEX

Earth Consultants Inc.
Geotechnical Engineering and Geology

LEGEND

Proj. No. 4360
Date Apr'89
Plate 3

APPENDIX B

TEST PIT NO. 1

Logged By JH
Date 3-29-89

Elev. 27±*

Depth (ft.)	USCS	Soil Description	W (%)
0		Topsoil	◁
	SM	Gray, silty SAND, trace to some gravel, moist, very dense. (Till)	6 9
5			7

Test pit terminated at 6 feet below existing grade. Light groundwater seepage encountered at 1' during excavation.

10

15

Logged By JH
Date 3-29-89

TEST PIT NO. 2

Elev. 19±*

Depth (ft.)	USCS	Soil Description	W (%)
0		Topsoil	◁
	sp	Fill: Brown gravelly fine SAND, trace silt, moist, loose to medium dense scattered organics.	8 9
5	sm	Gray, silty SAND, trace to some gravel, moist, very dense	8

Test pit terminated at 7 feet below existing grade. Light groundwater seepage encountered at 1' during excavation.

10

15

Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis, and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

Earth Consultants Inc.
Geotechnical Engineering and Geology

TEST PIT LOGS

EARTHSTONE/JOHNSTONE BUILDING
MERCER ISLAND, WASHINGTON

Proj. No. 4360	Date APR'89	Plate 4

APPENDIX B

TEST PIT NO. 3

Logged By JH

Date 3-29-89

Elev. 21±*

Depth (ft.)	USCS	Soil Description	W (%)
0	SM	Fill: Brown, gravelly, silty SAND, moist, loose to medium dense, scattered organics.	10
5	sm	Mottled brown to gray silty SAND, trace to some gravel, moist, dense to very dense	13 7
10			
15			

Test pit terminated at 7 feet below existing grade.
No groundwater seepage encountered during excavation.

Logged By JH

Date 3-29-89

TEST PIT NO. 4

Elev. 35'±*

Depth (ft.)	USCS	Soil Description	W (%)
0	sm	Topsoil: Brown to gray silty SAND, some gravel, moist, very dense	8 8
5			
10			
15			

Test pit terminated at 6 feet below existing grade.
No groundwater seepage encountered during excavation.

Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis, and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

Earth Consultants Inc.
Geotechnical Engineering and Geology

TEST PIT LOGS

EARTHSTONE / JOHNSTON BUILDING
MERCER ISLAND, WASHINGTON

Proj. No. 4360 **Date** Apr'89 **Plate** 5

APPENDIX B

APPENDIX B
E-4360
LABORATORY TESTING

General

We conducted laboratory tests on several representative soil samples to verify or modify the field soil classification of the units encountered and to evaluate the material's general physical properties and engineering characteristics. A brief description of each of the tests performed for this study is provided below. The results of laboratory tests performed on specific samples are provided either at the appropriate sample depth on the individual test pit log or on a separate data sheet contained in this Appendix. However, it is important to note that these test results may not accurately represent the overall in-situ soil conditions. All of our recommendations are based on our interpretation of these test results and their use in guiding our engineering judgement. Earth Consultants, Inc. (ECI) cannot be responsible for the interpretation of these data by others.

In accordance with our Standard Fee Schedule and General Conditions, the soil samples for this project will be discarded after a period of thirty (30) days following completion of this report unless we are otherwise directed in writing.

Soil Classification

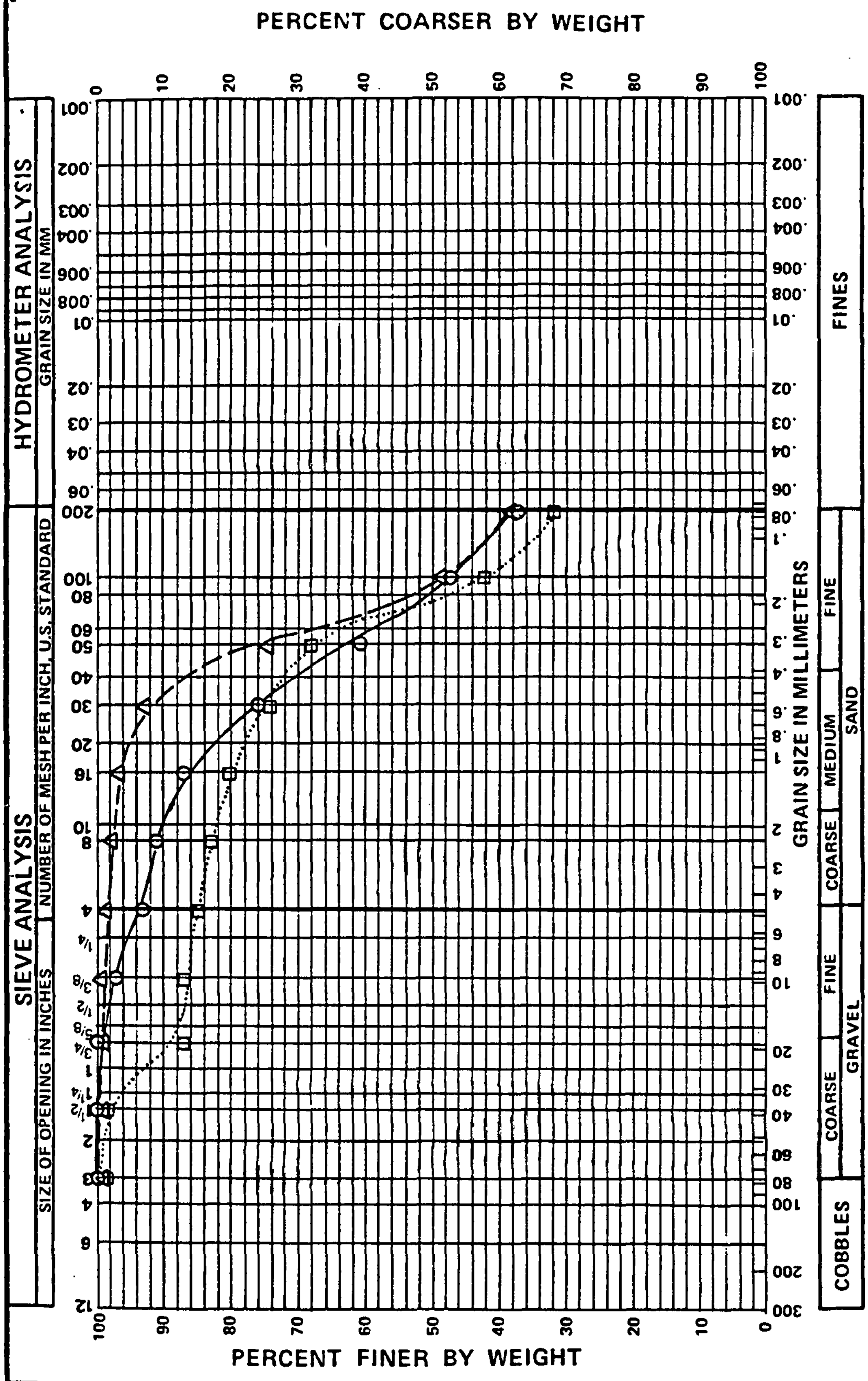
As mentioned earlier, all soil samples are visually examined in the field by our representative at the time they are obtained. They are subsequently packaged and returned to our Bellevue office where they are independently reexamined by one of our engineers and the original description is verified or modified, as necessary. With the help of information obtained from classification tests, the samples are described in general accordance with the Unified Classification System, ASTM Test Method D-2487-83. The resulting descriptions are provided at the appropriate sample location on the individual test pit log and are qualitative only. The attached Soil Classification/Legend, Plate 3, provides pictorial symbols that match the written descriptions.

Moisture

Moisture content tests were performed on all samples obtained from the test pits. The purpose of these tests is to approximately ascertain the in-place moisture content of the soil sample tested. The moisture content is determined in general accordance with ASTM Test Method D-2216-80. The information obtained assists us by providing qualitative information regarding soil strength and compressibility. The results of these tests are presented at the appropriate sample depth on the test pit logs.

Particle Size Analysis

Detailed grain size analyses were conducted on several of the shallow soil samples to determine the size distribution of the sampled soil. The information gained from this analysis allows us to provide a detailed description and classification of the in-place materials. In turn, this helps us to understand how the in-place materials will react when moved and reworked during earthwork operations. The results are presented on Plate 6, and classification symbols are provided as part of the appropriate individual sample descriptions on the test pit logs.



KEY	Boring or Test Pit No.	DEPTH (ft.)	USCS	DESCRIPTION	Moisture Content (%)	LL	PL
○———	TP-1	2	SM	Silty SAND	5.9		
△— — —	TP-1	3.5	SM	Silty SAND	8.8		
□........	TP-3	4	SM	Silty SAND	12.8		

Earth Consultants Inc.
Geotechnical Engineering and Geology

GRAIN SIZE ANALYSES

EARTHSTONE / JOHNSTON BUILDING
MERCER ISLAND, WASHINGTON

Proj. No. 4360 | Date Apr'89 | Plate 6

APPENDIX D

NGA
NELSON GEOTECHNICAL ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS & GEOLOGISTS

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East Wenatchee, WA 98802
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April 27, 2018

Ms. Sandra Lum
3728 East Mercer Way
Mercer Island, WA 98040

Geotechnical Engineering Evaluation
Lum Residence Retaining Walls and Slope Stabilization
3728 East Mercer Way
Mercer Island, Washington
NGA File No. 1027418

Dear Ms. Lum,

This report summarizes the results of our geotechnical engineering evaluation and stabilization recommendations of the steep slopes and existing block retaining walls located at your residence located at 3728 East Mercer Way on Mercer Island, Washington, as shown on the Vicinity Map in Figure 1. Our services were completed in general accordance with our services agreement signed by you on March 15, 2018.

INTRODUCTION

The purpose of this study is to explore and characterize the surface and subsurface conditions within the vicinity of the existing block retaining walls and steep slopes in order to provide our opinions and recommendations with respect to the stabilization of the slope and retaining wall system.

We visited the site on March 26, 2018 to observe the existing site conditions. We understand and observed that a series of tiered concrete block retaining walls were constructed within a steep northeast-facing slope area below and to the east of the existing residence. We were informed that these walls were constructed without a permit and the City of Mercer Island has requested a geotechnical evaluation be performed prior to approving wall construction or any proposed stabilization measures. You have requested that we explore the site within the vicinity of the lower steep east-facing slope and the block retaining walls and provide our opinion regarding the stability of the existing block walls, and to provide recommendations for potential repairs or improvements to the walls.

SCOPE

The purpose of this study is to explore and characterize the site subsurface conditions and provide recommendations for stabilizing affected areas. Specifically, our scope of services included the following:

1. A review of available soil and geologic maps of the area.
2. Exploring the subsurface soil and groundwater conditions within the eastern portion of the residence and in the vicinity of the retaining walls using a limited-access drill rig and hand auger explorations. Drill rig was subcontracted by NGA.
3. Mapping the conditions on the sloping areas below the residence and evaluate current slope stability conditions.
4. Providing our opinion regarding the construction and stability of the existing block retaining walls.
5. Providing recommendations for permanently stabilizing the affected areas, as needed.
6. Providing recommendations for potential retaining wall repairs or improvements.
7. Documenting the results of our findings, conclusions, and recommendations in a written geotechnical report.

SITE CONDITIONS

Surface Conditions

The site consists of a roughly rectangular-shaped parcel covering approximately 0.22 acres. The site is occupied by a multi-story, single-family residence adjacent to SE 36th Street in the central portion of the property. Moderate to steep northeasterly-facing slopes exist throughout the property, occupying areas to the east of the residence that descend from the eastern side of the residence to adjacent properties along a lower private access road. The majority of the tiered block walls were constructed along the surface of this slope. In addition, two short block walls occupy the area to the northwest of the residence and to the south of SE 36th Street, adjacent to the driveway area. The property is bordered to the west and south by existing single-family residences, to the north by SE 36th Street, and to the west by an access road leading to similar low-density residential development below. The site layout within the vicinity of the residence is shown on the Schematic Site Plan in Figure 2.

A series of tiered block retaining walls are located below and to the east of the residence along a moderate steep east-facing slope that descends from a relatively level upper bench where an existing deck is located to the eastern property line below along an access driveway. The steep, easterly-facing slopes steps down at gradients in the range of 25 to 26 degrees (47 to 49 percent grade). Profiles of the existing ground surface through the block wall areas, and the interpreted subsurface conditions within the steep slopes are presented in Cross Sections A-A' and B-B' in Figure 3 and 4. We observed that portions of the block retaining walls in the eastern portion of the site have experienced distress since construction, as they appear to be bowing and/or sagging in some areas. The three-tiered system in the eastern portion of the site contains walls which range from approximately 2.8 to 5.5 feet in exposed height. The middle tier is 9.0 feet away from the upper tier, and 11.7 feet from the lower tier. The base of the walls appears to be not embedded and no geogrid reinforcement was utilized in wall construction. In addition, several boulders were incorporated into the wall alignment, and are surrounded by concrete blocks. The overall height of the slope and tiered retaining walls below the residence is approximately 18 feet. The slope outside the retaining wall area in the east is bare and covered in plastic, but the wall area to the northwest is generally vegetated with underbrush and sparse mature trees. We did not observe indications of past sloughing events on the steep slopes outside of the retaining wall area. We also did not observe surface or seeping water in the immediate vicinity of the residence or on the slope during our site visit on March 26, 2018.

Subsurface Conditions

Geology: The geologic units for this area are shown on the Geologic Map of Mercer Island, Washington, by Kathy G. Troost and Aaron P. Wisher (GeoMapNW and the City of Mercer Island, 2006). The project site is mapped as surficial deposits of the Fraser Glaciation, consisting of Vashon Stade glacial till (Qvt). Glacial till is described as a non-sorted mixture of sand, silt, clay, and gravel. Our explorations generally encountered undocumented fill underlain by silty fine to medium grained sand with gravel, generally consistent with the description of the glacial till mapped in this area.

Explorations: The subsurface conditions within the site were explored on March 26, 2018 by drilling three borings with a limited-access drill rig extending between 4.0 and 11.5 feet below the existing ground surface within the east-facing steep slope. In addition, a 4.0 foot deep hand auger exploration was completed within the northwestern portion of the property. The approximate locations of our explorations are shown on the Schematic Site Plan in Figure 2. A geologist from Nelson Geotechnical Associates, Inc. (NGA) was present during the explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the explorations.

For the borings, a Standard Penetration Test (SPT) was performed on each of the samples during drilling to document soil density at depth. The SPT consists of driving a 2-inch outer-diameter, split-spoon sampler 18 inches using a 140-pound hammer with a drop of 30 inches. The number of blows required to drive the sampler the final 12 inches is referred to as the “**N**” value and is presented on the boring logs. The **N** value is used to evaluate the strength and density of the deposit.

The soils were visually classified in general accordance with the Unified Soil Classification System presented in Figure 5. The logs of our borings are attached to this report and are presented as Figures 6 through 8. We present a brief summary of the subsurface conditions in the following paragraph. For a detailed description of the subsurface conditions, the boring and hand auger logs should be reviewed.

In all of our explorations, we encountered approximately 1.0 to 6.0 feet of surficial brown, silty, fine to medium sand with gravel in a loose condition. We interpreted this material to be undocumented fill. Below the surficial fill, all explorations encountered gray to gray-brown, silty, fine to medium sand with varying amounts of iron oxidation staining and gravel in an increasingly dense condition to the depths explored, which was interpreted to be the native glacial till deposits. Borings 1, 2, and 3 were terminated within the native glacial soils at depths of 11.5, 10.5, and 4.0 feet below the existing ground surface, respectively. Hand Auger One was sterminated at a depth of 4.0 feet within the native glacial till.

Hydrologic Conditions

We did not encounter groundwater seepage in any of the explorations completed during our fieldwork. If groundwater were to be encountered within this site, we would consider this condition to be perched groundwater. Perched water occurs when surface water infiltrates through less dense, more permeable soils and accumulates on top of underlying, less permeable soils. Perched water does not represent a regional groundwater "table" within the upper soil horizons. Perched water tends to vary spatially and is dependent upon the amount of precipitation. We would expect the amount of perched water to decrease during drier times of the year and increase during wetter periods.

SENSITIVE AREA EVALUATION

Seismic Hazard

We reviewed the 2015 International Building Code (IBC). Since dense glacial soils are interpreted to underlie the site at depth, the site conditions best fit the IBC description for Soil Class C for native soils encountered at depth.

Hazards associated with seismic activity include liquefaction potential and amplification of ground motion. Liquefaction is caused by a rise in pore pressures in a loose, fine sand deposit beneath the groundwater table. It is our opinion that the competent native soils interpreted to underlie the site have a low potential for liquefaction or amplification of ground motion.

The medium dense or better soils interpreted to form the core of the site slope are considered stable with respect to deep-seated slope failures. However, the loose surficial materials and undocumented fill on the slope, if not removed or suitably stabilized, have the potential for failures during seismic events. Such events should not directly affect the existing residence provided the recommended repairs to the residence and slope stabilization measures are designed and implemented as described in this report.

Landslide Hazard/Slope Stability

The criteria used for evaluation of landslide hazards includes soil type, slope gradient, and groundwater conditions. Steep northeasterly-facing slopes with gradients between approximately 25 and 26 degrees (47 and 49 percent) with a height of approximately 18 feet, are located around the residence, mainly within the eastern portion of the site. We observed minor signs of distress within the retaining walls such as bowing. We did not observe significant indications of distress within the residence foundation.

Our explorations and observations indicate that the core of the steep slope below the fill consists primarily of competent glacial soils. It is our opinion that the core of the slope is stable and that the block wall repairs should terminate in stable soils. It is also our opinion that there is a significant potential for on-going failures within the loose surficial and undocumented fill soils on the steep slope if these soils are not stabilized. Proper site grading and drainage as well as stabilization techniques as recommended in this report should help improve current stability conditions. We also recommend that the slope be continually monitored for any indications of instability and stabilization measures be implemented immediately if they are observed.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion from a geotechnical standpoint that the existing block walls on the steep slope below the residence were not adequately installed and/or engineered, and are failing due to a combination of several factors. These factors include: lack of adequate drainage measures behind the walls, lack of geogrid reinforcement, supporting the walls on unsuitable material, inadequate wall toe embedment, and placement of unsuitable fill behind the walls. We also did not observe drainage system components, such as drain pipes and drain rock layers behind the retaining walls. Our explorations encountered up to 6.0 feet of loose undocumented fill soils that are not suitable as structural fill immediately surrounding some of the walls, in addition to the large boulders upon which portions of the wall are built. Multi-tiered retaining wall systems or retaining walls constructed on sloping ground need to have an engineered design and need to utilize geogrid reinforcement to support the backfill material. We understand that an engineered design was not used in the construction of the walls.

To restore the stability of the steep slope area below the residence, we recommend removing all of the concrete block retaining walls and associated loose soils from the steep slope area and reconstructing the tiered retaining wall system with the provided design. The new geogrid-reinforced fill walls could be constructed using the existing retaining wall blocks or new Keystone Compaq blocks. Loose native and undocumented fill soils are interpreted to underlie the slope areas that are not suitable for support of the recommended retaining walls. We recommend that the base of the new wall blocks and reinforced fill area be supported directly on competent native soils. The base of the new walls should be embedded a minimum of 18-inches below the finished ground surface.

We recommend that the existing tiered walls be replaced with no more than two walls. We anticipate that each tier will have a maximum exposed height of approximately 8.0 feet but may be higher depending on actual site elevations. We anticipate that the total wall height may be up to ten feet in order to satisfy a recommended base embedment of 18 inches below finished ground surface. This is discussed further in the **Wall Design and Construction Recommendations** subsection of this report. Due to the tight site constraints and the substantial amount of fill material that will need to be removed from the wall and reinforced fill area prior to construction of the walls, we stress that implementing proper planning and construction staging techniques will be key to achieve a successful outcome. NGA should be retained to review project plans prior to construction and should be retained to observe wall construction to verify wall installation is being performed in accordance with the plans and our recommendations provided in this report.

All residence drains including roof, driveway, footing, and yard drains along with drains associated with the proposed wall construction should be thoroughly investigated and directed to flow into an approved system. All existing drain pipes within the steep slope area should be abandoned and removed as a part of the drainage improvements.

Temporary and Permanent Slopes

Temporary cut slope stability is a function of many factors, including the type and consistency of soils, depth of the cut, surcharge loads adjacent to the excavation, length of time a cut remains open, and the presence of surface water or groundwater. It is exceedingly difficult under these variable conditions to estimate a stable, temporary, cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations since they are continuously at the job site, able to observe the soil and groundwater conditions encountered and able to monitor the nature and condition of the cut slopes.

The following information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Nelson Geotechnical Associates, Inc. assumes responsibility for job site safety. Job site safety is the sole responsibility of the project contractor.

For planning purposes, we recommend that temporary cuts in the on-site soils be no steeper than 2 Horizontal to 1 Vertical (2H:1V). If significant groundwater seepage or surface water flow were encountered, we would expect that flatter inclinations would be necessary. We recommend that cut slopes be protected from erosion. The slope protection measures may include covering cut slopes with plastic sheeting and diverting surface runoff away from the top of cut slopes. We do not recommend vertical slopes for cuts deeper than four feet, if worker access is necessary. We recommend that cut slope heights and inclinations conform to appropriate OSHA/WISHA regulations.

Permanent cut and fill slopes should be no steeper than 2H:1V. However, flatter inclinations may be required in areas where loose soils are encountered. If permanent slopes steeper than 2H:1V are created, we would anticipate such slope(s) to require on-going maintenance. Permanent slopes should be planted and the vegetative cover should be maintained until it is established. We should review plans and visit the site to evaluate excavations for this project.

Slope Improvements

Geogrid-Reinforced Block Wall Design and Construction: The total height of each of the recommended tiers is expected to be up to approximately 10 feet, including a minimum recommended embedment of 1.5 feet below the finished ground surface. We have provided wall designs for a tiered wall system with an individual tier height up to a 10-foot high retaining wall with Keystone block facing or utilizing the existing blocks on site. We recommend that walls be constructed utilizing geogrid reinforced backfill. The wall detail and design parameters along with construction notes are shown on Figure 10. Keystone Block wall calculations are provided in Appendix A. We have assumed that the retained fill zones will consist of granular material compacted to structural fill specifications. We understand that the fill will be placed level behind the walls and extending back into the slope. As indicated on the detail, the drainage system should be installed along the base of the blocks.

The block facing should consist of Keystone Compaq blocks or the existing blocks on site. The block facing should be placed on a minimum of 4-inch thick crushed rock leveling pads placed over competent native soils, or structural fill material prepared under the supervision of NGA. Unsuitable undocumented fill soils will likely be encountered at the retaining wall subgrades. We recommend that the wall and reinforced-fill subgrade be extended down to expose competent native soils. The wall and reinforced fill areas should also be graded to level benches prior to wall and reinforced fill construction. Since the walls will be terraced, we recommend that the lowest block retaining wall be constructed to completion prior to beginning construction of the upper walls. All tiers should be separated by a minimum horizontal distance that equals the total height of the tier below.

A drainage blanket of 12 inches of free-draining crushed rock should be placed between the blocks and the retained fill zone. The block cavities should also be filled with the crushed rock. A rigid, perforated drainpipe embedded in a minimum of 1-foot of pea gravel and wrapped in a filter fabric should be placed at the bottom of the drainage blanket. The drain should be sloped to drain into a permanent discharge point placed at the bottom of the slope.

Stratagrid SG500 geogrid (or equivalent) is recommended in the wall designs. The geogrid should be cut to the recommended lengths, attached to the blocks as recommended by the manufacturer, and extended back into the reinforced fill zone. The grid should be pulled tight before the fill is placed over the geogrid. Care should be taken not to damage the geogrid by operating construction equipment on the exposed grid, or by allowing large rocks to be placed directly on the grid.

All fill placed in the retained fill zone behind the retaining walls should be placed as structural fill. Structural fill, by definition, is placed in accordance with prescribed methods and standards and is monitored by an experienced geotechnical professional or soils technician. Field monitoring procedures would include the performance of a representative number of in-place density tests to document the attainment of the desired degree of relative compaction. The fill subgrade should consist of native medium dense or better native soil compacted to a non-yielding condition. The fill subgrade should consist of level benches.

Structural fill should consist of a good quality, granular soil, free of organics and other deleterious material and be well graded to a maximum size of about three inches. The material should have no more than 10 percent by weight of the portion passing the US #200 Sieve. We should be retained to evaluate proposed fill material prior to construction.

Following subgrade preparation, placement of structural fill may proceed. All fill placements should be accomplished in uniform lifts up to eight inches thick. Each lift should be spread evenly and be thoroughly compacted prior to placement of subsequent lifts. All structural fill should be compacted to a minimum of 95 percent of the material's maximum dry density. Maximum dry density, in this report, refers to that density as determined by the ASTM D 1557 Compaction Test procedure. The moisture content of the soils to be compacted should be within about two percent of optimum so that a readily compactable condition exists. It may be necessary to over-excavate and remove wet soils in cases where drying to a compactable condition is not feasible. All compaction should be accomplished by equipment of a type and size sufficient to attain the desired degree of compaction.

Site Drainage

If ground water seepage is encountered or if excessive rainfall occurs during construction of specific aspects, we recommend that the contractor slope the bottom of the excavations and direct the water to ditches and small sump pits. The collected water can then be directed to a suitable discharge point at the bottom of the slope.

We also recommend that all residence downspouts and yard drains be investigated to understand where they are directed. All drain pipes within the steep slope area should be abandoned and removed. If any irrigation systems are located within the steep slopes they should also be abandoned and removed. We recommend that all of the existing roof, footing, yard, and driveway drains associated with the residence be tightlined to flow into an approved system. NGA should be retained to evaluate the drainage systems as they are investigated and constructed.

CLOSURE

Based on our understanding of the proposed plans, and provided that the recommendations in this report are strictly followed during construction and the walls are constructed under the supervision of NGA, the areas disturbed by construction should remain stable. 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 meeting the requirements stated in Mercer Island City Code 19.07.060.D.2.a. Therefore, the risk of damage to the proposed development or to adjacent properties from soil instability should be minimal, and the proposed grading and development should not increase the potential for soil movement.

USE OF THIS REPORT

NGA has prepared this report for Ms. Sandra Lum and her agents, for use in the planning and design of the slope stabilization project on this site only. This letter is a specific evaluation of the observed soil settlement and related distress, and the existing concrete block retaining walls. The scope of our work does not include services related to construction safety precautions, and 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. There are possible variations in subsurface conditions between the explored and unexplored areas and also with time. Our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions. A contingency for unanticipated conditions should be included in the budget and schedule.

All people who own or occupy homes on hillsides should realize that landslide movements are always a possibility. The landowner should periodically inspect the slope, especially after a winter storm. If distress is evident, a geotechnical engineer should be contacted for advice on remedial/preventative measures. The probability that landsliding will occur is substantially reduced by the proper maintenance of drainage control measures at the site (the runoff from the roofs should be led to an approved discharge point). Therefore, the homeowner should take responsibility for performing such maintenance. Consequently, we recommend that a copy of our report be provided to any future homeowners of the property if the home is sold.

We recommend that NGA be retained to review final plans prior to construction. We also recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications. We should be contacted a minimum of one week prior to construction activities and could attend pre-construction meetings if requested.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this report was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

o-o-o

It has been a pleasure to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Carston Curd

Carston T. Curd, GIT
Staff Geologist

2883
LEE S. BELLAH

Lee S. Bellah, LG
Project Geologist

KHALED M. SHAWISH
35215

Khaled M. Shawish, PE
Principal

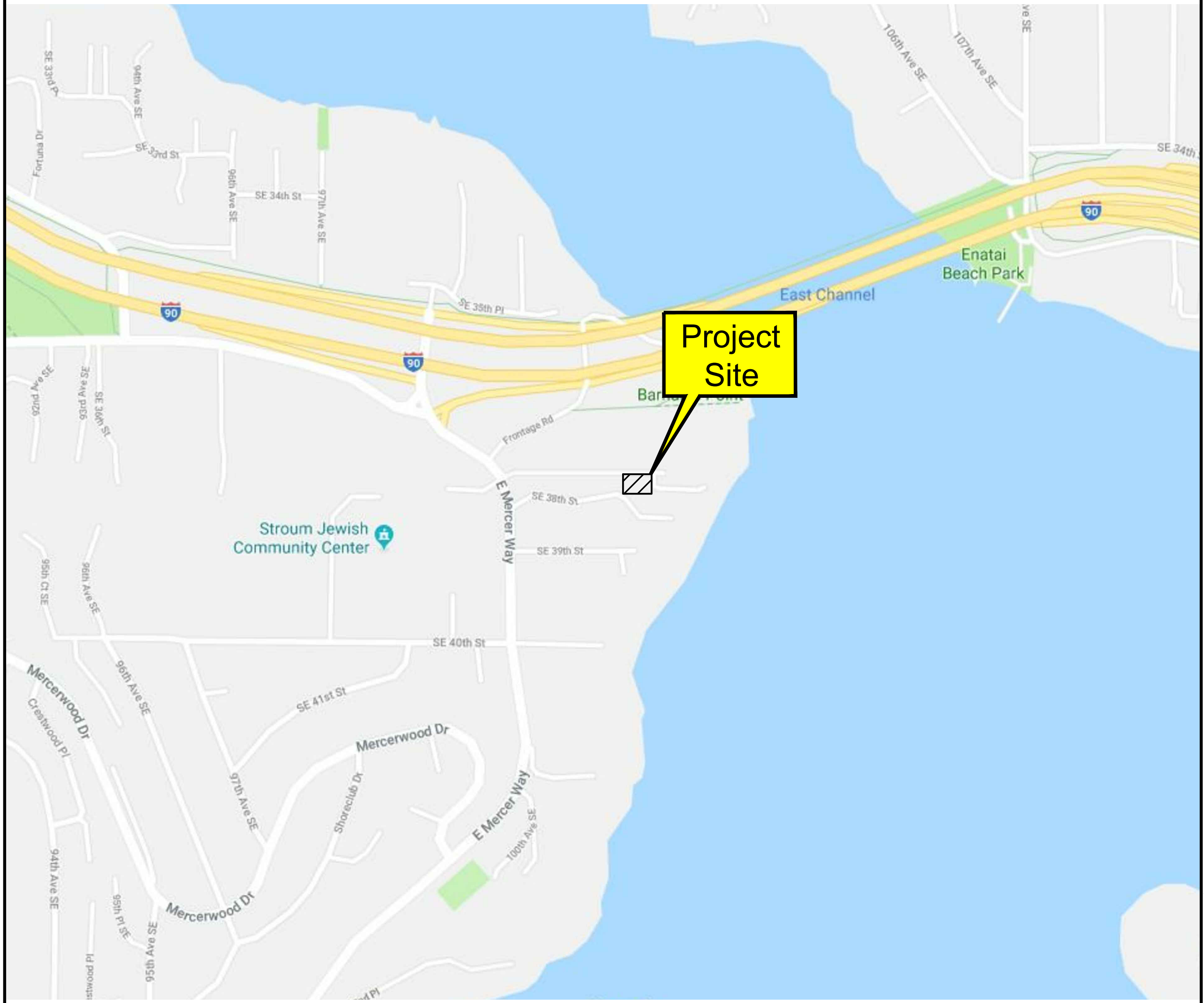
CTC:LSB:KMS:dy

Ten Figures and Appendix A Attached

VICINITY MAP

Not to Scale

N



Mercer Island, WA

Project Number
1027418

Figure 1

Lum Residence
Retaining Walls
Vicinity Map

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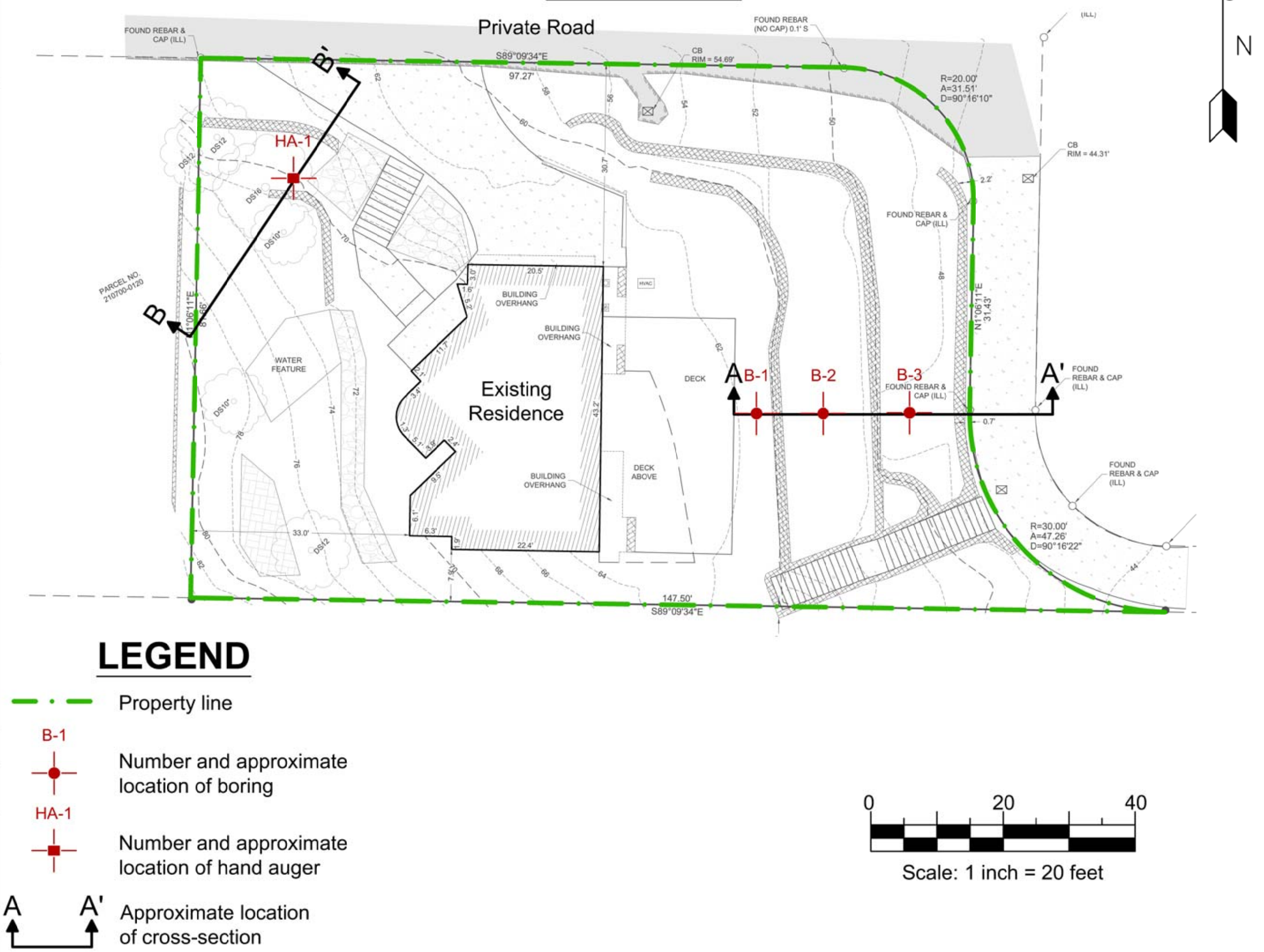
Site Plan



Reference: Site plan based on a plan dated November 19, 2017 titled "Topographic Survey - Kevin Lo," prepared by Site Surveying, Inc.

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Project Number 1027418	Lum Residence Retaining Walls Site Plan
Figure 2	

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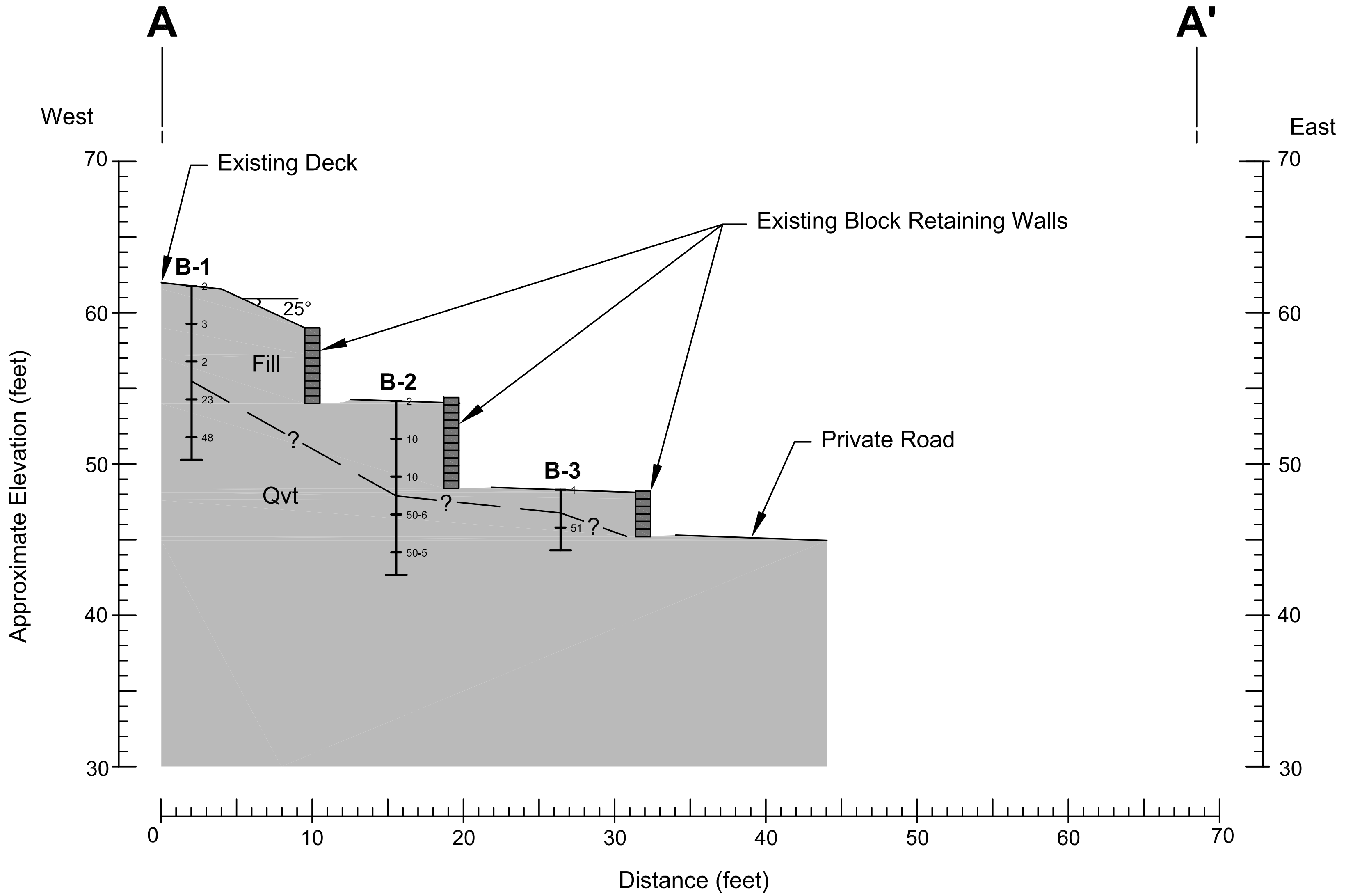
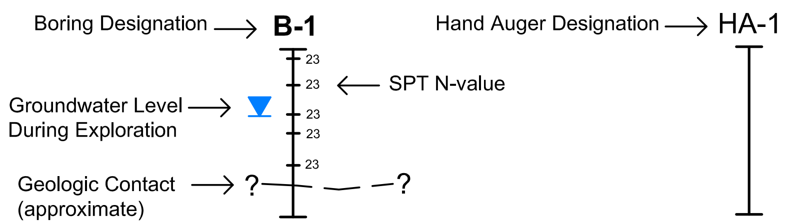


Exploration



NOTES:
1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are approximate.

Reference: Cross Section is based on field measurements using a hand-held clinometer and 100-ft tape measure.

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Figure 3

Lum Residence
Retaining Walls
Cross-Section A-A'

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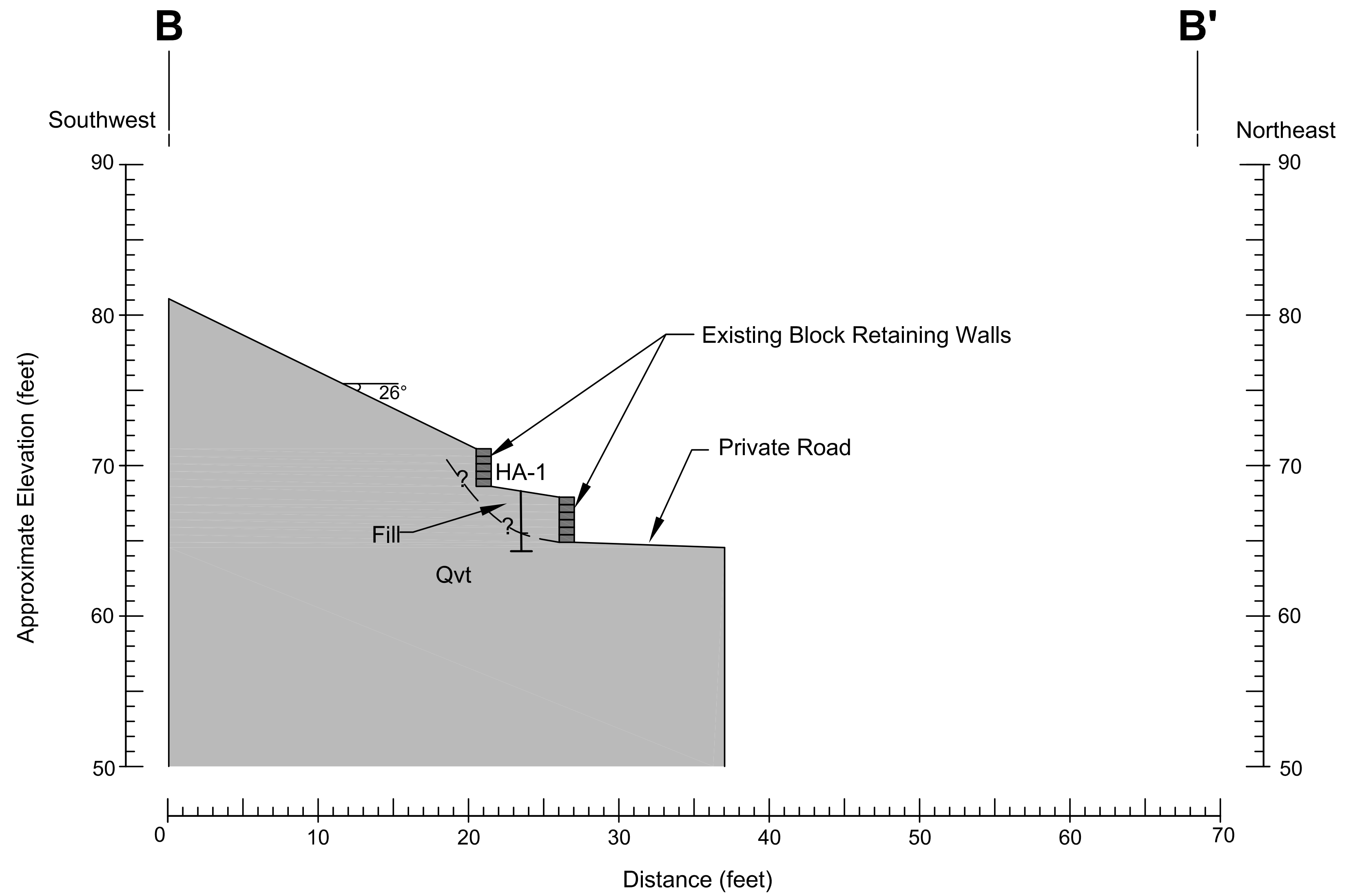
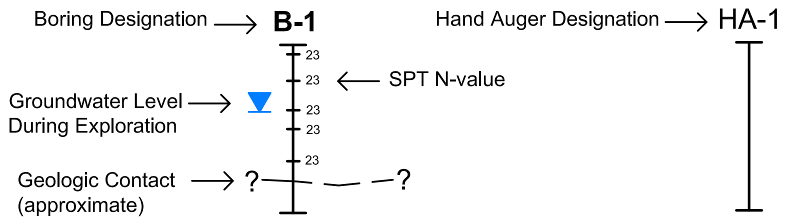


Exploration



NOTES:
1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are approximate.

Reference: Cross Section is based on field measurements using a hand-held clinometer and 100-ft tape measure.

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Figure 4

Lum Residence
Retaining Walls
Cross-Section B-B'

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UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE - GRAINED SOILS MORE THAN 50 % RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE - GRAINED SOILS MORE THAN 50 % PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50 %	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 % OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-93.

2) Soil classification using laboratory tests is based on ASTM D 2488-93.

3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water.

Wet - Visible free water or saturated, usually soil is obtained from below water table

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Figure 5

Lum Residence
Retaining Walls
Soil Classification Chart

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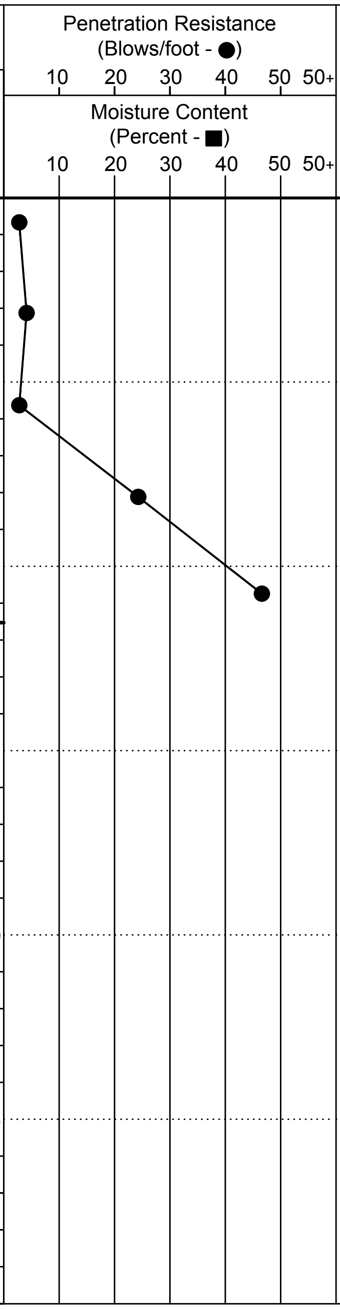
BORING LOG

B-1

Approximate Ground Surface Elevation: 62 ft.

Soil Profile			Sample Data	
Description	Graphic Log	Group Symbol	Blow Count	Sample Location (Depth in feet)
Brown, silty fine to medium sand with organics (very loose, moist to wet) (**FILL**)			2	■
-becomes fine to coarse sand, with trace iron-oxide staining			3 2	◪ ◪
Gray-brown, silty fine to coarse sand with trace gravel (very loose, moist)		SM		
-becomes gray to gray-brown, medium dense			23	■
-becomes dense			48	■
Boring terminated below existing grade at 11.5 feet on 3/26/18. Groundwater seepage was not encountered during drilling.				



Laboratory Testing

Piezometer Installation - Ground Water Data
(Depth in Feet)

5
10
15
20
25

LEGEND

- ◪ Depth Driven and Amount Recovered with 2-inch O.D. Split-Spoon Sampler
- ■ Depth Driven and Amount Recovered with 3-inch Shelby Tube Sampler
- □ Solid PVC Pipe
- ⊟ Slotted PVC Pipe
- ▨ Monument/ Cap to Piezometer
- ✱ Liquid Limit
- + Plastic Limit
- ▦ Concrete
- ▧ Bentonite
- ▩ Native Soil
- ⬚ Silica Sand
- ▼ Water Level

M	Moisture Content
A	Atterberg Limits
G	Grain-size Analysis
DS	Direct Shear
PP	Pocket Penetrometer Readings, tons/ft
P	Sample Pushed
T	Triaxial

NOTE: Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

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Lum Residence
Retaining Walls
Boring Log

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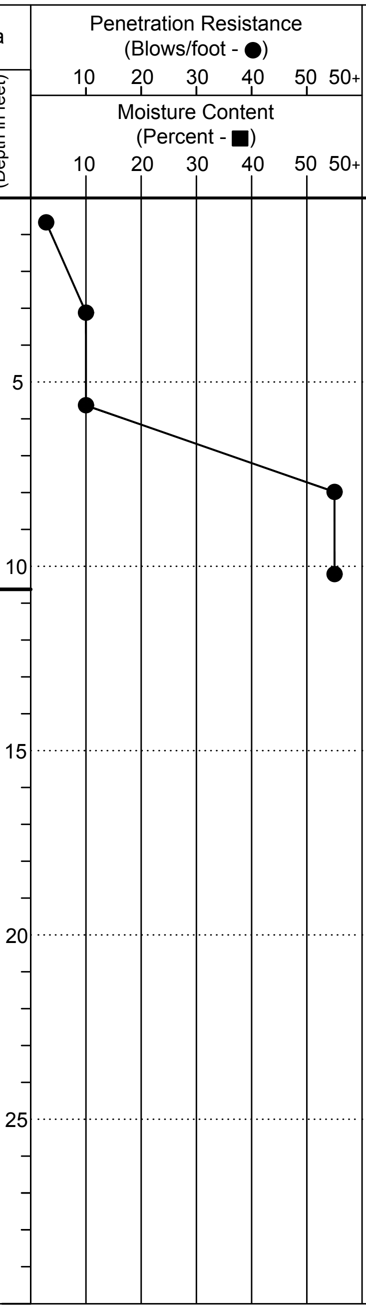
BORING LOG

B-2

Approximate Ground Surface Elevation: 56 ft.

Soil Profile			Sample Data	
Description	Graphic Log	Group Symbol	Blow Count	Sample Location (Depth in feet)
Brown, silty fine to medium sand (very loose, moist to wet) (**FILL**)			2	■
-becomes fine to coarse sand, loose to medium dense			10	⬓
-becomes fine to medium sand, with trace iron-oxide staining			10	⬓
Gray, silty fine to coarse sand with trace gravel (very dense, moist) -becomes gray-brown	▨	SM	50-6" 50-5"	■ ■
Boring terminated below existing grade at 10.5 feet on 3/26/18. Groundwater seepage was not encountered during drilling.				



Laboratory Testing

Piezometer Installation - Ground Water Data
(Depth in Feet)
5
10
15
20
25

LEGEND

⬓	Depth Driven and Amount Recovered with 2-inch O.D. Split-Spoon Sampler	🟩	Solid PVC Pipe	▨	Concrete	M	Moisture Content
■	Depth Driven and Amount Recovered with 3-inch Shelby Tube Sampler	⊟	Slotted PVC Pipe	▨	Bentonite	A	Atterberg Limits
		🟥	Monument/ Cap to Piezometer	▨	Native Soil	G	Grain-size Analysis
		*	Liquid Limit	▨	Silica Sand	DS	Direct Shear
		+	Plastic Limit	▼	Water Level	PP	Pocket Penetrometer Readings, tons/ft
						P	Sample Pushed
						T	Triaxial

NOTE: Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

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Lum Residence
Retaining Walls
Boring Log

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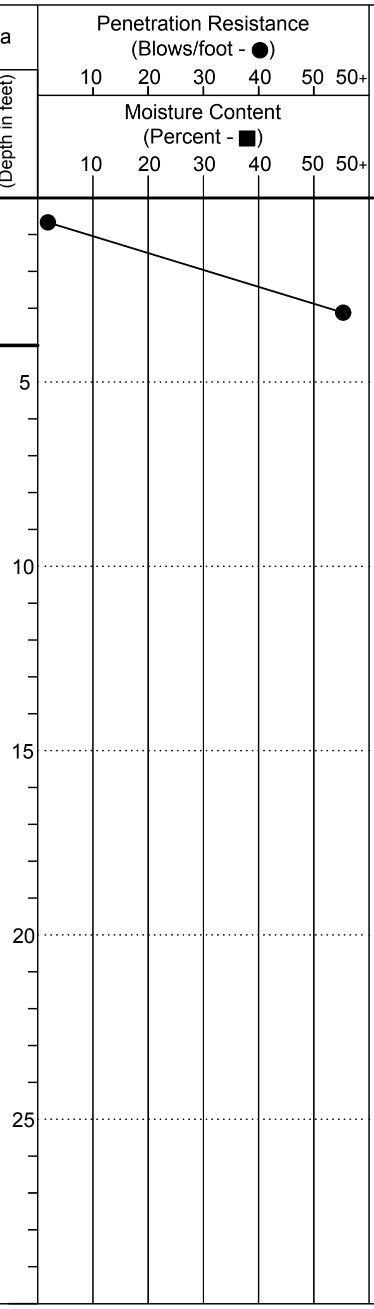
BORING LOG
B-3

Approximate Ground Surface Elevation: 48 ft.

Soil Profile			Sample Data		Laboratory Testing	Piezometer Installation - Ground Water Data (Depth in Feet)
Description	Graphic Log	Group Symbol	Blow Count	Sample Location (Depth in feet)		
Brown, silty fine to medium sand (very loose, moist to wet) (**FILL**)			1	■		
Gray-brown, silty fine to coarse sand with trace gravel (very dense, moist)	▨	SM	51	■		
Boring terminated below existing grade at 4.0 feet on 3/26/18. Groundwater seepage was not encountered during drilling.						5 10 15 20 25



LEGEND

■ Depth Driven and Amount Recovered with 2-inch O.D. Split-Spoon Sampler

■ Depth Driven and Amount Recovered with 3-inch Shelby Tube Sampler

🟩 Solid PVC Pipe

🟩 Slotted PVC Pipe

🟥 Monument/ Cap to Piezometer

* Liquid Limit

+ Plastic Limit

▨ Concrete

▨ Bentonite

▨ Native Soil

▨ Silica Sand

▼ Water Level

M Moisture Content
A Atterberg Limits
G Grain-size Analysis
DS Direct Shear
PP Pocket Penetrometer Readings, tons/ft
P Sample Pushed
T Triaxial

NOTE: Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

Project Number	Lum Residence Retaining Walls Boring Log
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LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
HAND AUGER ONE		
0.0 – 2.8		BROWN TO GRAY-BROWN, SILTY FINE TO MEDIUM SAND WITH TRACE GRAVEL AND ROOTS (LOOSE, MOIST) (**FILL**)
2.8 – 4.0	SM	GRAY, SILTY FINE TO COARSE SAND (DENSE, DRY TO MOIST)
		SAMPLES WERE NOT COLLECTED GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED HAND AUGER CAVING WAS NOT ENCOUNTERED HAND AUGER WAS COMPLETED AT 4.0 FEET ON 3/26/18

DPN:CTC

NELSON GEOTECHNICAL ASSOCIATES, INC.

FILE NO 1027418

FIGURE 9