March 8th, 2024 G-6035

Mr. Johnson Chen
6175 SE 27th Street
Mercer Island, WA 98040
Email: jchen@johnsondesignhomes.com

Subject: **Geotechnical Engineering Investigation**
Proposed Residence
6175 SE 27th Street
Mercer Island, WA 98040

Dear Mr. Chen,

In accordance with our contract dated February 26, 2024, GEO Group Northwest, Inc. has prepared a geotechnical report regarding the proposed single family residence at the subject property in Mercer Island, Washington. The report includes the findings of our subsurface investigation, as well as our conclusions and geotechnical recommendations regarding the proposed residence.

SITE CONDITIONS

Site Description

The project site (Parcel No. 2174503305) is located in Mercer Island, Washington, as shown on the attached Plate 1 – Site Location Map. The site is approximately 7,775 square feet (0.18 acres) in size. The project site is accessed by 27th Street. The maximum elevation at the project site is approximately 92 feet and is located near the project site's northeastern corner. The minimum elevation at the project site is approximately 76 feet and is located near the project site's northwestern corner. In general, slopes at the site gently slope downwards to the west.

Project Description

We understand that the proposed construction consists of a two story single-family residence with a basement garage; the proposed residence is illustrated on the attached Plate 2 – Proposed Site Section. In general, the project area for the house is relatively flat with an upward slope on the northeastern side and a downward slope on the northwestern side of the property.

GEOLOGIC OVERVIEW

According to the published geologic mapping of the area (Geologic Map of Mercer Island, Troost et al., 2006), the site overlies Pre-Olympia Fine-grained deposits.

Pre-Olympia Deposits

Fine-grained deposits (Qpof): These deposits typically consist of predominantly silt and clay with sandy interbeds. Additionally, there is often found to be localized iron-oxide cemented layers with sandy partings in this soil type. These deposits were subsequently overridden and compacted by the Puget lobe of the Vashon glacier, approximately 15 thousand years ago.

SUBSURFACE INVESTIGATION

On March 7th, 2024, a geologist from our firm visited the site to perform a visual reconnaissance of the property and investigate the subsurface soil conditions at the site. We drilled two exploratory soil borings (HA-1, HA-2) using hand operated auger equipment during our visit. Locations of borings are shown on the attached Plate 3 – Proposed Site Plan. We evaluated density of the soils encountered in the borings and collected samples of the soils for further analysis at our office.

Soils encountered in Boring HA-1 consisted of medium dense, brown silty sand with sub angular gravel to depths of approximately 1.3 feet below ground surface (bgs). Soils encountered below approximately 1.3 to 2 feet bgs consisted of loose, light brown silty sand with subangular gravels. Soils encountered below approximately 2 feet to 2.8 feet bgs consisted of loose silty sand with subangular gravels. Groundwater seepage was observed at approximately 3.3 feet. At approximately 4 feet bgs, the soils consisted of medium dense silty sand with plenty or red mottling, without cobbles or gravels. The boring was terminated at a depth of approximately 4 feet bgs.

Soils encountered in Boring HA-2 consisted of dense, light brown silty sand with subrounded cobbles and subangular gravels, to a depths of approximately 1 feet bgs. Soils encountered below 1 to 1.6 feet bgs consisted of dense light brown silty sand with subrounded cobbles and sub angular gravels. Soils encountered from approximately 1.6 to 3 feet bgs consisted of medium dense, dark brown silty sand with subangular gravel, and glass fragments. Soils encountered below 3 to 3.9 feet consisted of dense silty sand with subrounded gravels and abundant red mottling. Soils encountered from approximately 3.9 feet to 5 feet bgs consisted of, loose silty sand with subrounded cobbles and some subangular gravels with plenty of red mottling. The boring was terminated at a depth of 5 feet. No groundwater was encountered in boring HA-2.

The dense soils encountered in the borings HA-1 and HA-2 are interpreted to be Pre-Olympia age fine-grained deposits, overlain with loose to medium dense fill soils.

For a more detailed description of the soils encountered during our subsurface investigation, please refer to the soil logs on the attached Appendix A – USCS Soil Classification & Soil Boring Logs.

GEOLOGICAL HAZARD AREA

Geological Hazard Area Investigation

The City of Mercer Island's definitions for geological hazard areas are provided in Mercer Island's City Code Chapter 19.16.010 (MICC 19.16.010). It is our understanding that the proposed new residence is located in areas mapped by Mercer Island as erosion and landslide hazard areas at the project site. A map illustrating locations of the mapped geological hazard areas are provided in Plate 4 – Geologic Hazard Map (MICC 19.07.160.C).

Erosion Hazard Area

Approximately half of the project site is mapped by Mercer Island as an erosion hazard area. The mapped erosion hazard area extends beyond the project site to the adjacent properties to the northeast and southeast. Current mapping of erosion hazard areas is based upon past regional soils mapping by several government agencies and is generalized. Although the construction area is mapped as an erosion hazard area, no evidence of erosion was observed during our visual reconnaissance of the project site.

Land Slide Hazard Area

According to Mercer Island's GIS mapping and Mercer Island City Code (19.16.010) landslide hazard areas have been mapped as approximately half the site. The mapped landslide hazard area extends beyond the project site to the adjacent properties to the northeast and southeast. During our visual reconnaissance we did not observe any evidence of slope instability or previous landslides at the project site. No historic landslides are mapped at the project site, or its vicinity, according to available landslide mapping by WA DNR and Mercer Island's hazard mapping. Additionally, the surface conditions of the site were observed to be well vegetated with trees and shrubs.

Geological Hazard Areas Evaluation

It is our opinion that the risk of landslides are minimal at the site, because of the over-consolidation of soils underlying the project site. It is also our opinion that the risk of soil erosion at the project site and adjacent properties is minimal, these can be mitigated through proper implementation of temporary and permanent erosion and sedimentation controls during and after construction. Our recommendations regarding erosion control are provided in the conclusions and recommendations section of this report.

SITE SEISMIC DESIGN CLASSIFICATIONS

Per the procedures specified in ASCE Standard 7-16, the project site can be assigned a seismic design classification as Site Class D (Stiff Soil Profile). This conclusion is based on review of the geologic mapping of the site vicinity, the conditions encountered in the boring excavated on the site, and our understanding and interpretation of deeper subsurface condition at the site. Seismic design parameters applicable for the site are as follows:

S_S = 1.4g	S_{MS} = 1.4g	S_{DS} = .934 g
S_1 = 0.488g	S_{M1} = null	S_{D1} = null

The peak ground acceleration for the site, adjusted for the assigned site class, is 0.659g per current seismic hazard design mapping and calculations conforming to ASCE Standard 7-16.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our visual reconnaissance, subsurface investigation, and our understanding of the proposed construction, we anticipate that the construction of the residence can be completed without increasing the risk of erosion or slope instability at the project site, as well as without increasing the risk of damage to neighboring properties can be mitigated such that the site is determined to be safe; provided that our recommendations are properly implemented during construction. Details of our recommendations regarding the geotechnical aspects of the proposed construction are described in the following sections of this report.

Statement of Risk

It is our opinion that the proposed construction has been designed so that the risk to the lot and adjacent property is mitigated such that the site is determined to be safe, provided that our geotechnical recommendations are implemented.

Earthwork

Erosion Control

Prior to construction commencing, temporary erosion and sedimentation controls (TESCs) should be installed to prevent the flow of sediment-laden runoff from the site and to minimize the potential for on-site soil erosion. Appropriate TESCs for the project include silt fences, compost socks, straw mulch, hay bales, or other devices appropriate for the site conditions.

Concentrated surface water should not be allowed to flow over exposed slopes or into excavations. During wet weather, exposed slopes should be covered with plastic sheeting to minimize erosion, and accumulated surface water should be directed toward temporary settlement or collection points for treatment and discharge, as appropriate for the site conditions, per a construction stormwater management plan.

Water also should not be allowed to stand in any area where the proposed residence is 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. If necessary, a construction entrance consisting of 2- to 4-inch size crushed rock should be installed to prevent tracking onto the street.

Site Clearing

The project area should be cleared of vegetation, topsoil, organics, debris, and any other deleterious materials that are found. These materials should be hauled off site or used for landscaping, as appropriate; they should not be used as structural fill or retaining wall backfill for the project.

Excavations and Slopes

Temporary excavation slopes should not be greater than the limits specified in local, state and federal government safety regulations. Temporary cuts which are greater than 4 feet in height typically can be sloped at inclinations up to 1H:1V (Horizontal: Vertical). In situations where water seepage or other adverse conditions are observed, temporary cuts in these soils may need to be made at shallower inclinations if recommended by the geotechnical engineer. If adequate space is not available to maintain open cuts per the recommendations in this report, engineered support may be required to provide lateral support to such excavations. Permanent unreinforced slopes at the site should be inclined no steeper than 2.5H:1V.

Surface runoff should not be allowed to flow over the top of slopes into excavations. During wet weather, exposed slopes should be covered with plastic sheeting to prevent erosion or softening. We recommend that a GEO Group Northwest representative be on site during excavation of cut slopes to verify anticipated geologic conditions and to evaluate slope stability, particularly if groundwater seepage, caving soils, or debris are encountered.

Wet Weather Season Earthwork Considerations

We recommend that the following measures be implemented in supplement or replacement with the erosion and sediment control recommendations for earthwork during the wet weather season.

- Cut and fill slopes exposed during construction should be covered with plastic sheeting when they are not being worked. Soil stockpiles also should be covered when not being worked.

- Structural fill should consist of free-draining material with not more than 5% of the material passing a #4 sieve.

- Earthwork should not be performed during periods of heavy precipitation, in order to minimize rutting and tracking of soils by construction equipment traffic. Equipment that has lower potential to cause rutting or other soil disturbance should be used.

- Soil subgrades in areas where footings or slabs are to be built should be protected from softening due to standing water or to disturbance.

- Erosion control measures, such as silt fences, straw bales and wattle, etc., should be arranged to control soil erosion and sediment travel as appropriate within the project area as well as along its downslope and cross-slope perimeter of the project area's limits.

- Earthwork should be completed in phases, where feasible, to limit the extent of exposed soil during the project.

- We recommend that we visit the project site upon completion of the installation of the TESCs to verify their suitability. During earthwork to prepare the residence location for construction, we recommend that we visit the site if precipitation greater than 0.5 inches in a 24-hour period occurs, in order to monitor the performance of the TESC measures and monitor excavation stability. We also recommend that we are able to verify that the materials being used are appropriate for wet weather conditions and are being properly placed and compacted in general accordance with our recommendations.

Subgrade Preparation

After the completion of site clearing and excavation, soils in areas to receive structural fill, concrete slabs, sidewalks, or pavements, should be prepared to a dense, unyielding condition. The prepared subgrade should be observed and approved by the geotechnical engineer. Any detected soft spots or disturbed areas should be compacted or excavated and replaced with compacted structural fill or crushed rock as directed by the geotechnical engineer.

Structural Fill

Structural fill is typically defined as earthen material that is placed below buildings (including foundations and on-grade slab floors), sidewalks, driveways, or other structures, and provides support to those structures. Material which is stored on site for later use as structural fill should be covered with plastic sheeting to protect it from moisture if its usability is sensitive to its moisture content. Structural fill material should be placed and compacted in accordance with the recommendations provided below or as otherwise approved by the geotechnical engineer during construction. Site soils are not anticipated to be suitable for use as structural fill due to their fine gradation and moisture content.

Fill Material Specifications

Material used as structural fill should not contain rocks or clasts larger than 3 inches in its greatest dimension. During wet weather, the material should be granular in character, with a fines content (passing a #200 sieve) of less than 5 percent. The material should be placed at or near its optimum moisture content. If the material is too wet to be compacted to the required degree, it will be necessary to dry the material by aeration (which may be difficult), or to replace the material with an alternative suitable material in order to achieve the recommended compaction.

Compaction Specifications

Structural fill material placed under foundation footings and concrete floor slabs should be compacted to at least 92 percent of its maximum dry density as determined by ASTM D1557. Structural fill material under exterior slabs or pavements should be compacted to at least 90 percent of its maximum dry density, except for the top 12 inches of the material, which should be compacted to at least 95 percent of its maximum dry density.

Structural fill material should be spread and compacted in lifts that are 10 inches or less in thickness in an un-compacted state. The compacted fill material should be field tested by using ASTM Designations D2922 and D3017, Nuclear Probe Method, to verify that the required degree of compaction has been achieved, or be approved by the geotechnical engineer.

Foundations

Based on the results of our subsurface investigation, soils suitable for building foundations are anticipated at depths greater than 4 feet below ground surface at the project area. The proposed residence can be supported on spread footing foundations if the geotechnical engineer can verify during the construction that dense soils are encountered at the design footing elevation. Our recommendations for the spread footings constructed on the sites suitable soils, or on structural fill placed above the sites suitable soils are provided below.

Spread Footing Foundations

Our recommended design criteria for conventional footing foundations supported on suitable native soils or structural fill are provided below.

- Allowable bearing pressure, including all dead and live loads:
  - Undisturbed, medium dense or dense soil = 2,000 psf
  - Structural fill placed on medium dense or dense soil = 2,000 psf
- Minimum depth to base of perimeter footing below adjacent exterior grade = 18 inches
- Minimum depth to bottom of interior footings below top of floor slab = 12 inches
- Minimum width of wall footings = 16 inches
- Minimum lateral dimension of column footings = 24 inches
- Estimated post-construction settlement = ½ inch
- Estimated post-construction differential settlement across building width = ½ inch

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

Lateral loads against the building foundations can be resisted by friction between the foundation and the supporting subgrade or by passive earth pressure acting on the buried portions of the foundations. For the latter case, the foundations must be poured "neat" against the existing undisturbed soil or be backfilled with compacted structural fill. Our recommended parameters are as follows:

- Passive Pressure (Lateral Resistance)
  - 350 pcf, as an equivalent fluid weight, for structural fill or competent undisturbed native soil.
- Coefficient of Friction (Friction Factor)
  - 0.35 for structural fill or competent undisturbed native soil.

Slab on Grade

For the basement garage, the slab-on-grade floors should be constructed on a firm, unyielding subgrade. During preparation of the slab subgrade, any areas of the subgrade that have been disturbed by construction activity should be either re-compacted or excavated and replaced with compacted structural fill. We recommend that structural fill placed below slab-on-grade floors conform to the earthwork and grading recommendations provided in this report.

To avoid moisture build-up on the subgrade, the floor slab should be placed on a capillary break, which is in turn placed on the prepared subgrade. The capillary break should consist of a 6”-minimum thick layer of crushed rock or gravel that contains no more than five percent material finer than a No. 4 sieve. A vapor barrier, such as a 10-mil plastic membrane, should be placed over the capillary break and taped or sealed to minimize water vapor transmission upward through the slab, if post-construction vapor transmission is undesirable.

Basement Walls

Based on the proposed site section illustrated on Plate 2, we understand that the proposed residence is to include basement walls. As such, we have prepared the following recommendations.

Wall Support

Permanent retaining walls restrained horizontally on top (such as basement walls) are considered unyielding and should be designed for a lateral earth pressure under the at-rest condition; while conventional, unrestrained, retaining walls (i.e. that are free to rotate) should be designed for an active lateral earth pressure. Walls should be fully drained to minimize buildup of hydrostatic pressure. For basement wall drainage design details, please refer to the attached Plate 5 - Typical Basement Wall Drainage. The following engineering parameters can be used for the design of these walls under fully drained conditions. Preparation for wall support should be monitored and approved by the geotechnical engineer during construction.

Active Earth Pressure

Conventional reinforced concrete walls that are allowed to yield an amount equal to or greater than 0.002 times the wall height, should be designed to resists an active lateral earth pressure of 35 pounds per cubic foot (pcf), as an equivalent fluid pressure, for cases where ground behind the walls is level (horizontal). We should be consulted to provide additional recommendations regarding surcharge load effects if rising backslopes or buildings are planned to be located in proximity to the walls.

At-Rest Earth Pressure

Walls supported horizontally by floor slabs are considered unyielding and should be designed for lateral earth pressure under the at-rest condition. The walls should be designed to resist a lateral earth pressure of 45 pcf, as an equivalent fluid pressure, for cases where the ground behind the wall is level. We should be consulted to provide additional recommendations regarding surcharge load effects if rising backslopes or buildings are planned to be located in proximity to the walls.

Seismic Earth Pressure

8H psf, where H is the wall height, imposed as a rectangular pressure against the full height of the retaining wall to account for seismically induced dynamic soil loads. Seismic earth pressure is not applicable to catchment walls.

Passive Earth Pressure

350 pcf, equivalent fluid weight, for competent native soils or structural fill.

Base Coefficient of Friction

0.35 for competent native soils or structural fill.

The backfill in areas adjacent to retaining walls should be compacted with handheld equipment (such as a jumping jack) or with a small hoe-pack. Heavy compaction machines should not be allowed within horizontal distance to the wall equivalent to one half of the wall height, unless the walls are designed to accommodate the added surcharge.

Drainage

Surface Drainage

Water should not be allowed to stand in areas where foundations or on-grade slabs are to be constructed. During construction, loose surfaces should have been sealed at night by compacting the surface to reduce the potential for moisture infiltration into the soils. Final site grades should direct surface water away from the proposed residence.

Subsurface Drainage

We recommend that footing drains be installed around the exterior perimeter of the foundation's footing. The footing drains should consist of a four (4) inch diameter perforated rigid PVC drain pipe laid with perforations downwards, at or slightly above the bottom of the footing with a gradient sufficient to generate flow. The drain line should be bedded on, surrounded by, and covered with a free-draining aggregate; river rock, or equivalent. The drain rock and drain line should both be completely surrounded by a geotextile filter fabric, Mirafi 140N or equivalent. Once the footing drains are installed, the excavation should be backfilled with a compacted fill material. The footing drains should be tight lined to discharge to an approved storm water collection system. Under no circumstances should the footing drainage system be connected to roof downspout drain lines.

LIMITATIONS

This report has been prepared for the specific application to this site for the exclusive use of Mr. Johnson Chen and their authorized representatives. Any use of this report by other parties is solely at that party's own risk. We recommend that this report be included in its entirety in the project contract documents for reference during construction. The findings and recommendations stated herein are based on field observations, our experience on similar projects and our professional judgment. The recommendations presented herein are our professional opinions derived in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area and within the project schedule and budget constraints. No warranty is expressed or implied. In the event that site conditions are found to differ from those described in this report, we should be notified so that the relevant recommendations in this report can be reevaluated and modified if appropriate.

CLOSING

We appreciate the opportunity to provide you with geotechnical engineering services for this project. Please do not hesitate to contact us if you have any questions regarding this report.

Sincerely,
GEO Group Northwest, Inc.

Matthew Dulski

Matthew Dulski
Staff Engineering Geologist

February 26th, 2024

William Chang, P.E.
Principal Engineer

Attachments:

- Plate 1 – Site Location Map
- Plate 2 – Proposed Site Section
- Plate 3 – Proposed Site Plan
- Plate 4 – Geological Hazard Map
- Plate 5 – Typical Basement Wall Drain

Attachment A - USCS Soil Classification & Soil Boring Logs

Source: King County iMap, 2024.

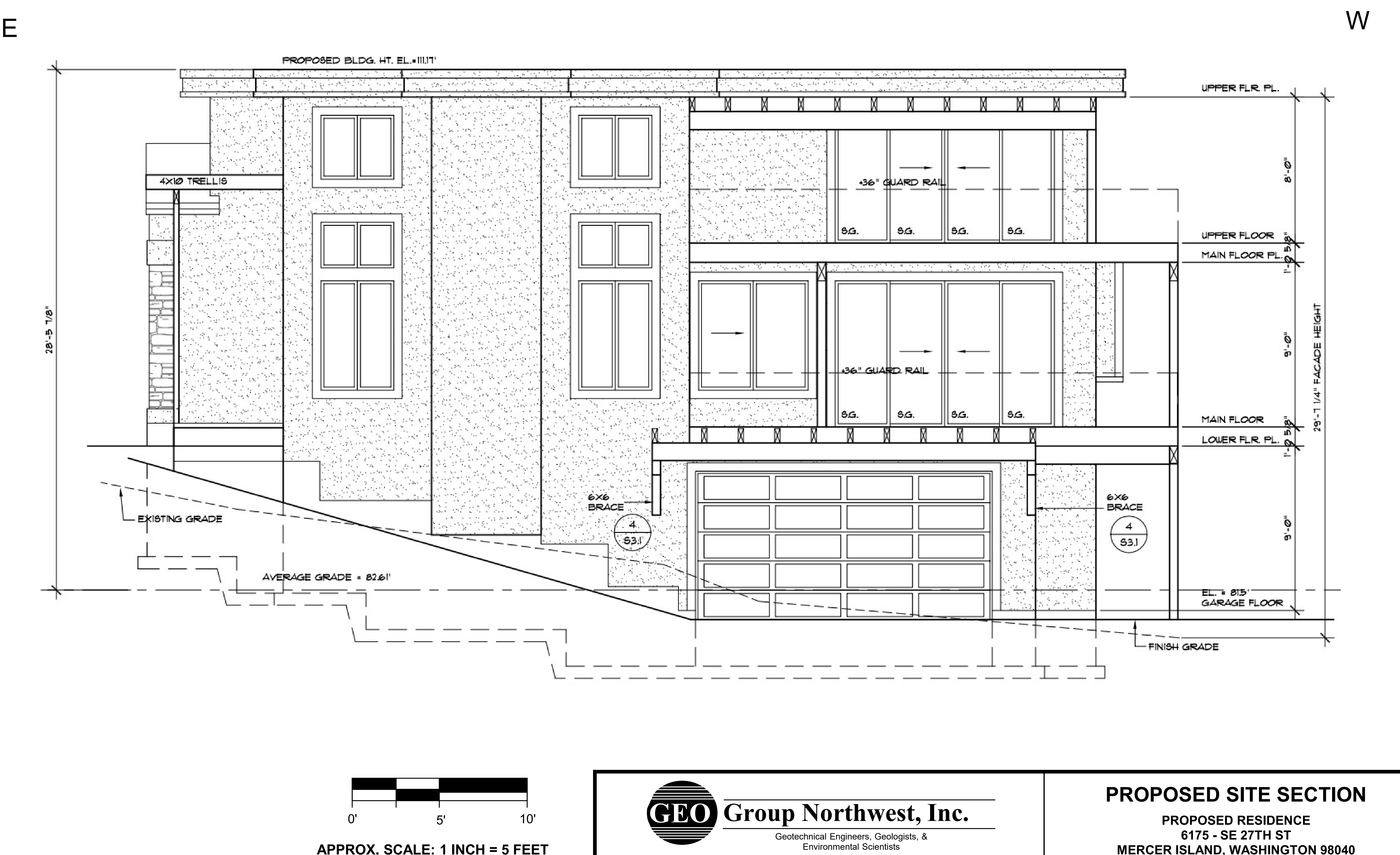
GEO Group Northwest, Inc.

Geotechnical Engineers, Geologists, & Environmental Scientists

SITE LOCATION MAP

PROPOSED NEW RESIDENCE
6175 - SE 27TH ST
MERCER ISLAND, WASHINGTON 98040

SCALE:	NONE	**DATE:**	3/13/2024	**MADE:**	MD	**CHKD:**	WC	**JOB NO:**	G-6035	**PLATE**	1



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PROPOSED SITE SECTION

PROPOSED RESIDENCE
6175 - SE 27TH ST
MERCER ISLAND, WASHINGTON 98040

SCALE	AS SHOWN	DRAWN BY	MD	CHECKED BY	WC	DATE	3/13/2024	PROJECT NO.	G-6035	PLATE	2

LEGEND

EXPLORATORY HAND AUGER SOIL BORING LOCATION (APPROXIMATE)

HA-1

0' 10' 20'

APPROX. SCALE: 1 INCH = 10 FEET

Base from: SITE PLAN, prepared by Cambium Inc., dated 5/17/23.

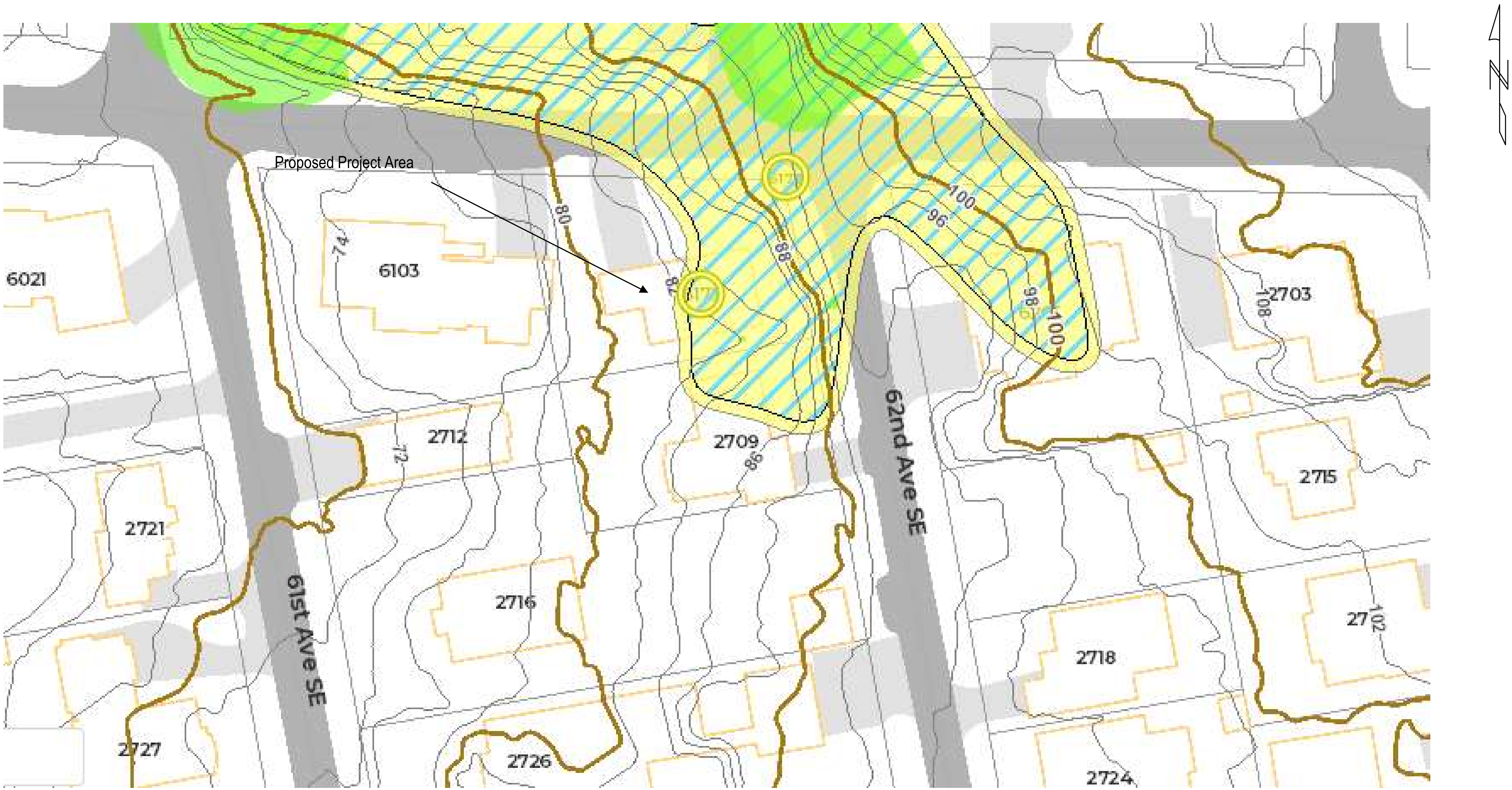
GEO Group Northwest, Inc.

Geotechnical Engineers, Geologists, & Environmental Scientists

PROPOSED SITE PLAN

PROPOSED RESIDENCE
6175 - SE 27TH ST
MERCER ISLAND, WASHINGTON 98040

SCALE	AS SHOWN	DRAWN BY	MD	CHECKED BY	WC	DATE	3/13/2024	PROJECT NO.	G-6035	PLATE	3



LEGEND

- Protected Slope Area
- Erosion
- Potential Slide

0' 40' 80'

APPROX. SCALE: 1 INCH = 40 FEET

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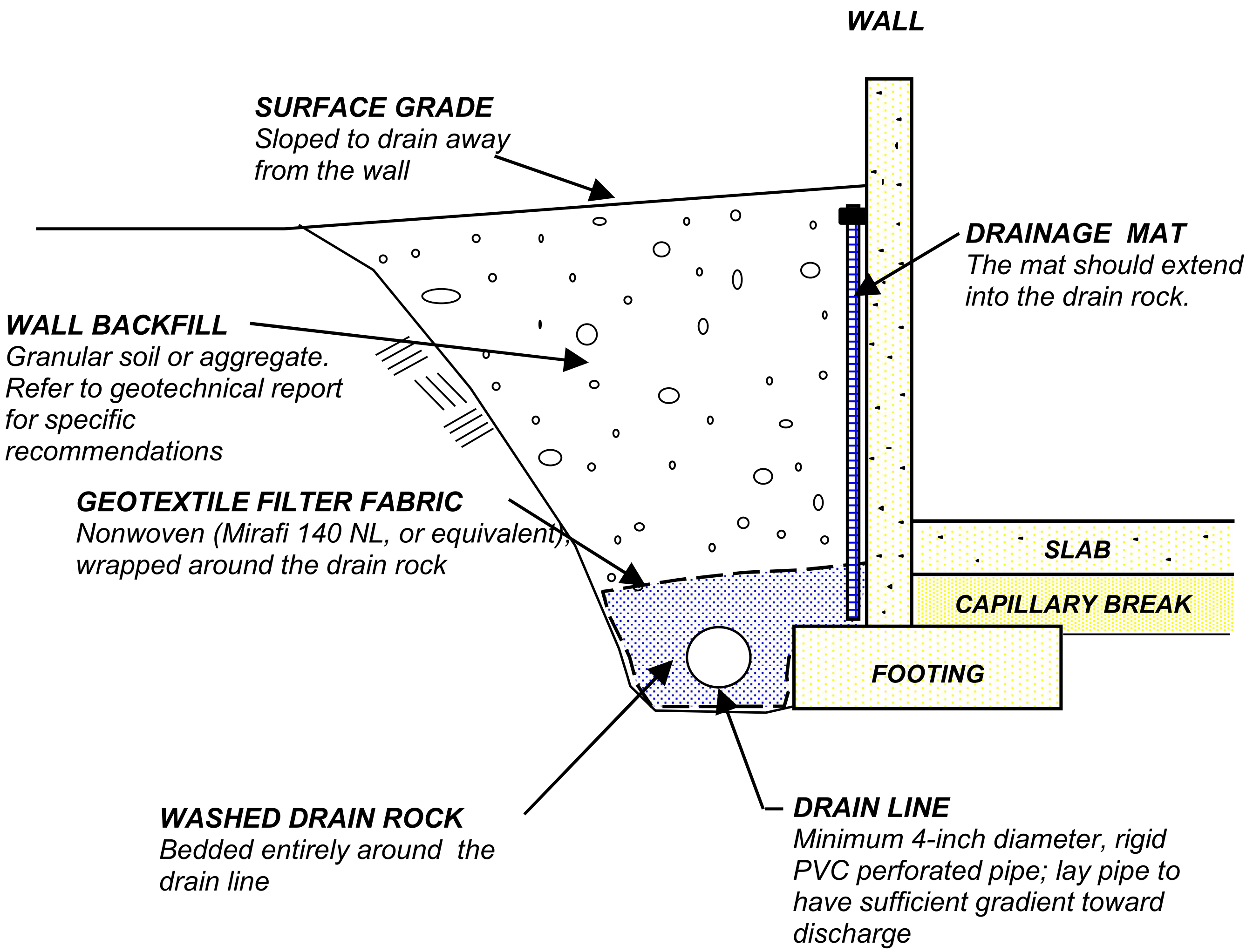
GEOLOGIC HAZARD MAP

PROPOSED RESIDENCE
6175 - SE 27TH ST
MERCER ISLAND, WASHINGTON 98040

SCALE	AS SHOWN	DRAWN BY	MD	CHECKED BY	WC	DATE	3/13/2024	PROJECT NO.	G-6035	PLATE	4

TYPICAL BASEMENT WALL DRAIN



NOT TO SCALE

NOTES:

1.) Do not replace rigid PVC pipe with flexible corrugated plastic pipe.

2.) Perforated PVC pipe should be tight jointed and laid with perforations oriented downward. The pipe should be gently sloped to provide flow toward the tightline or discharge location.

3.) Do not connect other drain lines into the footing drain system.

4.) Backfill should meet structural fill specifications if it will support driveways, sidewalks, patios, or other structures. Refer to the geotechnical engineering report for structural fill recommendations.

5.) Surface grade above the backfill can be covered with a layer of relatively impermeable topsoil or pavement or slab to reduce infiltration of surface water into the backfill and drainage system

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TYPICAL BASEMENT WALL DRAIN

PROPOSED RESIDENCE
6175 - SE 27TH ST
MERCER ISLAND, WASHINGTON 98040

SCALE NONE	**DATE** 3/13/2024	**MADE** MD	**CHKD** WC	**JOB NO.** G-6035	**PLATE** 5

HAND-AUGER BORING: HA-1

LOGGED BY MD **LOG DATE:** March. 2024 **GROUND ELEV.** 86 feet +/-

DEPTH ft.		USCS	SOIL DESCRIPTION	SAMPLE No.	Water %	OTHER TESTS/ COMMENTS
1		SM	Silty SAND, brown grey, medium dense, with some subangular gravel &subrounded cobbles, red mottling.	S1	18	-Probe 2.5" at 16"
2		SM	Silty SAND, light brown grey, subangular gravel, rounded cobbles.	S2	13.5	-Probe 4.5" at 24"
3		SM	Silty SAND, light brown grey, loose, few subrounded gravels, black mottling.	S3	32	-Probe 4.0" at 34"
4		SM	Silty SAND, light gray brown, dense, wet, red mottling.	S4	23.8	-Probe .5" at 48"
5						
6						
7			Total depth = 4 Feet Groundwater Seepage encountered at 3.3 Feet			

HAND-AUGER BORING: HA-2

LOGGED BY MD **LOG DATE:** March. 2024 **GROUND ELEV.** 80 feet +/-

DEPTH ft.		USCS	SOIL DESCRIPTION	SAMPLE No.	Water %	OTHER TESTS/ COMMENTS
1		SM	Silty SAND, light brown, dense, small subangular gravel and subrounded cobbles.	S1	10.5	-Probe .25" at 12"
2		SM	Silty SAND, light brown grey, dense, subanglar gravel and small subrounded cobbles, black and red mottling present.	S2	10.1	-Probe 0" at 20"
3		SM	Silty SAND, grey brown, loose , subangular gravel and subrounded cobbles, red mottling.	S3	22.1	-Probe 3.5" at 36"
4		SM	Silty SAND, grey red, dense, small subrounded gravel and pleanty of red mottling.	S4	19.2	-Probe .25" at 47"
5		SM	Silty SAND, redish grey, loose, small subrounded cobbles and subangular gravels, pleanty of red mottling.	S5	22.6	-Probe 3" at 60"
6						
7			Total depth = 5 Feet groundwater not encountered			

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HAND AUGER BORING LOGS

PROPOSED RESIDENCE
11708 DOLPHIN POINT TRAIL SW
VASHON, WASHINGTON 98070

JOB NO. G-6035 **DATE** 3/7/24 **ATTACH.** A