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March 29, 2021

JN 21062

Kam Derakshani
8151 Southeast 48th Street
Mercer Island, Washington 98040
via email: derakshani@msn.com

Subject: **Transmittal Letter – Geotechnical Engineering Study and Critical Area Study**
Proposed Residence Remodel
8151 Southeast 48th Street
Mercer Island, Washington

Dear Mr. Derakshani:

Attached to this transmittal letter is our geotechnical engineering report and Critical Area Study related to geologic hazards for the proposed residence remodel in Mercer Island. The scope of our services consisted of exploring site surface and subsurface conditions, and then developing this report to provide recommendations for general earthwork, stormwater infiltration considerations, and design considerations for foundations, retaining walls, subsurface drainage, and temporary excavations/shoring. This work was authorized by your acceptance of our proposal, dated February 10, 2021.

The attached report contains a discussion of the study and our recommendations. Please contact us if there are any questions regarding this report, or for further assistance during the design and construction phases of this project.

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

Adam S. Moyer
Geotechnical Engineer

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ASM/JHS:kg

GEOTECHNICAL ENGINEERING STUDY AND CRITICAL AREA STUDY
Proposed Residence Remodel
8151 Southeast 48th Street
Mercer Island, Washington

This report presents the findings and recommendations of our geotechnical engineering study and Critical Area Study for the site of the proposed residence remodel in Mercer Island. The scope of the Critical Area Study is intended to satisfy the requirements of the recently-adopted section 19.07.110 of the Mercer Island City Code (MICC), which applies to Critical Area Studies.

We were provided with preliminary plans of the remodel and a topographic map of the subject site. Centerline Design developed the provided preliminary plans, and Site Surveying, Inc. developed the topographic survey, which is dated August 18, 2020. Based on the provided plans, we understand that the existing residence will be extensively remodeled. A basement underlies the southern third of the existing house footprint. The proposed remodel will include expanding the basement to the north to create a new basement garage beneath the central third of the house. The northern perimeter of the new basement garage will align with the southern edge of the existing attached garage on the northern end of the house's main floor; the basement garage will also extend approximately 13 feet west of the house's western perimeter. Based on the provided plans, the basement garage will have a slab elevation of 159.8 feet. We anticipate a bottom-of-excavation near an elevation of 157.8 feet to account for the depth of the new footings. Therefore, temporary excavations up to 10.5 feet are anticipated beneath surrounding ground surface and main floor elevation of 168.4 feet.

The existing pool west of the house will be demolished to construct a new driveway which will descend to the new basement garage below; concrete retaining walls will border the northern and southern sides of driveway as it descends below grade. A covered deck will be located over the driveway and be supported on the perimeter driveway retaining walls. Finally, the existing main floor bump-out off the southern perimeter of the residence is supported by posts on shallow near-surface concrete pier pads which appear to have settled slightly. The proposed remodel will include replacing the foundations of the main floor bump out off the southern end of the residence. Minimal excavations are expected for this portion of the remodel.

If the scope of the project changes from what we have described above, we should be provided with revised plans in order to determine if modifications to the recommendations and conclusions of this report are warranted.

SITE CONDITIONS

SURFACE

The Vicinity Map, Plate 1, illustrates the general location of the site on the western, central portion of Mercer Island just west of West Mercer Way. The generally rectangular-shaped subject site is located on the eastern side of the southern end of Southeast 48th Street. The subject site has dimensions of 150 feet in the east-west direction and approximately 110 feet in the north-south direction. A T-shaped, one-story, single-family residence is located near the center of the property; the northern 66 feet of the residence has an approximate width of 25.3 feet. However, the southern 23.3 feet of the residence expands to a width of 48.2 feet. A basement underlies the southern third of residence. A small 21-foot-wide bump out addition extends several feet south of the residence's southern perimeter at the main floor elevation. This bump out addition is supported by three posts on irregular isolated concrete pier pads near the ground surface.

An elevated pool surrounded by a deck is located west of the central portion of the residence. An asphalt driveway connects to Southeast 48th Street in the northeast corner of the property; the driveway runs along the northern perimeter of the pool to an attached garage on the northern end of the residence. A vehicle turnaround and/or open parking spots are located west of the pool. A concrete patio extends off the eastern perimeter of the central third of the residence at the main floor elevation of 168.4 feet. A grass lawn with planter areas covers the remainder of the back yard on the eastern end of the property as well as in the southwest corner of the property.

Most of the subject site slopes gently downwards from northeast to southwest at an average inclination of about 11 percent. However, the southern perimeter of the property slopes steeply downwards to the south. The grade drops 20 to 30 feet to the south, across the southern property line, to the base of a ravine feature on the neighboring parcels. The ravine descends to the west-southwest towards Lake Washington. Based on the provided topographic survey, the southern slope has an inclination of 44 to 60 percent. The top of the steep slope is offset approximately 4 to 5 feet from the southern perimeter of the house and wraps around the southeast corner of the house up to the higher eastern backyard.

The City of Mercer Island's GIS tool maps the subject site within several geologic hazard areas. The subject site, and the general vicinity are mapped as both a potential landslide hazard area and an erosion hazard area. With the exception of its northwest corner, the subject site is also mapped as a seismic hazard area.

We did not observe any indications of recent slope instability or erosion on or around the site during our recent visit to the property.

SUBSURFACE

The subsurface conditions were explored by drilling two test borings and digging one test hole at the approximate locations shown on the Site Exploration Plan, Plate 2. Our exploration program was based on the proposed construction, anticipated subsurface conditions and those encountered during exploration, and the scope of work outlined in our proposal.

The test borings were drilled on March 4, 2021 using a track-mounted, hollow-stem auger drill. Samples were taken at approximate 2.5- or 5-foot intervals with a standard penetration sampler. This split-spoon sampler, which has a 2-inch outside diameter, is driven into the soil with a 140-pound hammer falling 30 inches. The number of blows required to advance the sampler a given distance is an indication of the soil density or consistency. A geotechnical engineer from our staff observed the drilling process, logged the test borings, and obtained representative samples of the soil encountered. The Test Boring Logs are attached as Plates 3 and 4.

An engineer from our firm also excavated a test hole on the property on March 4, 2021 using hand auger equipment.

Soil Conditions

The test borings encountered a thin layer of loose silty sand fill soils beneath the ground surface. Native loose silty sand was revealed beneath the fill at depths of 1 to 2 feet. The underlying native silty sand became medium-dense to dense below 2.5 to 3.5 feet and became denser with depth.

Test Boring 1 was drilled near the southwest corner of the residence near the top of the southern steep slope. Loose native silty sand was encountered below 2 feet, which became medium-dense below 3.5 feet. Below 7.5 feet, the silty sand became dense and slightly cemented; these dense cemented silty sand soils were deposited and compressed by glaciers thousands of years ago and are referred to geologically as glacial till. The dense glacial till extended to the maximum-explored depth of 21.5 feet.

Test Boring 2 was conducted in the driveway directly north of the existing pool. The medium to dense glacial till was encountered below 2.5 feet and became very dense below 6.5 feet. However, a thin layer of medium-dense to dense, wet, sand was revealed within the glacial till from 5 to 6.5 feet.

A test hole was excavated with hand auger equipment alongside the western existing pier pad footing supporting the southern bump out addition. The test hole revealed that the pier pad has a depth of 12 inches below the ground surface, and bears on loose silty sand fill soils. The test hole was terminated due to refusal on large gravels within the loose fill soils at a depth of 4 feet.

No obstructions were revealed by our explorations. However, debris, buried utilities, and old foundation and slab elements are commonly encountered on sites that have had previous development.

Groundwater Conditions

Groundwater seepage was encountered in sand seams within the glacial till that underlies the subject site. In Test Boring 1, very thin perched groundwater seams were encountered at 11 feet and 21 feet. As discussed above, a larger sand seam was encountered from 5 to 6.5 feet in Test Boring 2 with perched groundwater within it. The test borings and test hole were left open for only a short time period. It should be noted that groundwater levels vary seasonally with rainfall and other factors. We anticipate that groundwater could be found perched on top of or within sand seams within the relatively impervious underlying dense glacial till. This is most likely to occur following extended wet weather.

The stratification lines on the logs represent the approximate boundaries between soil types at the exploration locations. The actual transition between soil types may be gradual, and subsurface conditions can vary between exploration locations. The logs provide specific subsurface information only at the locations tested. If a transition in soil type occurred between samples in the borings, the depth of the transition was interpreted. The relative densities and moisture descriptions indicated on the test boring logs are interpretive descriptions based on the conditions observed during drilling.

CRITICAL AREAS STUDY (MICC 19.07)

Seismic Hazard and Potential Landslide Hazard Areas: The entire subject site is located within a mapped Potential Landslide Hazard area and most of the subject site is located within a mapped Seismic Hazard Area. Both geologic hazard areas cover much of the general vicinity as well. As previously discussed, the core of the subject site consists of dense to very dense glacial till which has a low potential for deep-seated landslides. No recent large-scale movement has been documented in this area. The proposed development will be supported on conventional footings or deep foundations (pipe piles) embedded into the underlying glacial till which is not liquefiable, due to its dense nature and the absence of near-surface groundwater. This mitigates the Seismic Hazard.

Steep Slope Hazard Areas: Based on the provided topographic map of the subject site, the southern perimeter of the property slopes downwards to the south at an inclination of at least 40 percent over a horizontal distance of 30 feet (which the City of Mercer Island code defines as a Steep Slope). A Steep Slope is a qualification as a Landslide Hazard Area under the Mercer Island Code. The southern perimeter of the existing house is offset approximately 4 to 5 feet from the top of the southern steep slope, and has no signs of settlement. However, the existing shallow pier pad footings which support the existing southern main floor bump out addition have little to no offset from the top of the steep slope, and appear to be supported on loose fill soils placed during the original development. Part of the proposed work will be to replace (underpin) these shallow pier pad footings with concrete pile caps supported by small-diameter pipe piles driven into the very dense underlying glacial till which comprises the core of the steep slope. This will remove the existing surcharge load from the bump out addition on the loose upper fill soils on top of the steep slope, and improve the stability of the slope. The footprint of the house alongside the top of the steep slope will remain unchanged and the actual house additions will be located on the northern portion of the existing house away from the steep slope. It is our opinion that no buffers or setbacks are needed between the new development areas and the Steep Slope, provided the recommendations presented in this report are followed. The recommendations presented in the report are intended to prevent adverse impacts to the stability of the slope onsite.

Erosion Hazard Areas: The entire subject site also meets the City of Mercer Island's criteria for an Erosion Hazard Area. The temporary erosion control measures needed during the site development will depend heavily on the weather conditions that are encountered during the site work. One of the most important considerations, particularly during wet weather, is to immediately cover any bare soil areas to prevent accumulated water or runoff from the work area from becoming silty in the first place. A wire-backed silt fence supported on metal fence posts and bedded in compost, not native soil or sand, should be erected as close as possible to the planned work area, and the existing vegetation on the steep slope below the silt fence should be left in place. No soil should be placed on the steep slope south of the silt fence, even temporarily. It will also be very important that any collected water be directly away from the top of the adjacent steep slope. Cut slopes and soil stockpiles should be covered with plastic during wet weather. Soil stockpiles should be minimized. Following rough grading, it may be necessary to mulch or hydroseed bare areas that will not be immediately covered with landscaping or an impervious surface.

Buffers and Mitigation: Under MICC 19.07.160(C), the code-prescriptive buffer of 25 feet is indicated from all sides of a shallow landslide-hazard area. As noted above, the entire site lies within a mapped Potential Landslide Hazard Area, and the prescriptive buffer would extend far beyond the boundaries of the property and the planned development area.

We recognize that the planned development will occur within the designated critical areas and their applicable prescriptive buffers. The proposed house additions are on the northern half of the existing house and not near the southern steep slope area. The recommendations presented in this geotechnical report are intended to allow the new foundations for the project to be constructed in the proposed configuration without the need for a buffer from the top of the steep slope. Following the recommendations of this report, the planned development will not adversely impact the stability of the neighboring properties, or result in a need for increased critical area buffers on those adjacent properties. The geotechnical recommendations associated with proposed foundations, shoring, and erosion control will mitigate any potential hazards to geologic critical areas on the site.

Statement of Risk: In order to satisfy the City of Mercer Island's requirements, a statement of risk is needed. As such, we make the following statement:

> *The design and construction practices recommended in this report for the alteration will render the development as safe as if it were not located in a geologically hazardous area and will not cause adverse geotechnical impacts to the adjacent properties*

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

THIS SECTION CONTAINS A SUMMARY OF OUR STUDY AND FINDINGS FOR THE PURPOSES OF A GENERAL OVERVIEW ONLY. MORE SPECIFIC RECOMMENDATIONS AND CONCLUSIONS ARE CONTAINED IN THE REMAINDER OF THIS REPORT. ANY PARTY RELYING ON THIS REPORT SHOULD READ THE ENTIRE DOCUMENT.

The test borings encountered dense to very dense silty sand (glacial till) at depths of 2.5 to 7.5 feet beneath the ground surface from north to south along the western perimeter of the existing residence. Based on our explorations, the proposed basement garage excavations beneath the residence will reach the dense to very dense underlying glacial till. Conventional footings constructed directly on the glacial till are well-suited to support the proposed basement and the vertical loads from the building above.

It will be important that great care be taken during excavation to maintain the high bearing capacity of these soils. Excavation using a toothed bucket usually leaves several inches of disturbed soils. The loosened soil must be entirely scraped out of the base of the footing excavations. This should be accomplished with a flat-bladed bucket, a grade bar that is dragged with the bucket, or by hand-shoveling the loose soil out of the excavation. The glacial till is silty in nature and therefore very moisture sensitive; thus, if the footing subgrade soil is wet, or becomes wet at the time of foundation construction, we recommend covering the bearing surfaces with either several inches of clean crushed rock immediately after the excavation is completed. This is intended to protect the footing subgrade soils from becoming softened by foot traffic during the footing forms and rebar placement, which will be a particular concern during wet conditions.

Excavation for the proposed basement garage beneath the existing house will be an important geotechnical consideration. Although dense glacial till was encountered at a relatively shallow depth beneath the adjacent driveway, a 1.5-foot-thick sand seam with perched groundwater was encountered within the glacial till between depths of 5 and 6.5 feet. If temporary open cut slopes are used, the perched groundwater may cause sloughing of the sands at the cut face. To prevent this, and to minimize the extent of the excavation, we recommend a maximum 7-foot-tall temporary Ultrablock shoring wall be installed along the upslope northern perimeter of the proposed basement garage excavation. The Ultrablocks may be installed vertically, provided a "return" block wall section is installed to the south from the eastern perimeter of the shoring wall. A temporary 1:1 (Horizontal:Vertical) cut slope may be used upslope of the block wall. Even with the temporary Ultrablock shoring, it appears the southern end of the existing garage slab (at the main floor elevation) north of the new basement garage will need to be demolished to excavate the remaining upper 1:1 (Horizontal:Vertical) temporary cut slope above the shoring wall. It will also be necessary to temporarily underpin the southern ends of the existing garage's eastern and western perimeter footings to complete the excavation below with cribbage or small-diameter pipe piles.

We understand that the foundations for the existing main floor bump out addition that extends south of the residence will be replaced during the residence remodel. Based on our test hole conducted near the western existing pier pad supporting the bump out, the existing shallow footings bear on loose fill soils that were placed along the top of the adjacent steep slope to the south. We recommend the existing bump out addition be supported on pipe piles driven into the underlying very dense glacial till. It should be noted that the side sewer may be located south of the residence, which may affect the location of the pipe piles.

Wet weather construction (October 1 through March 31) on this site should be possible without adverse impacts to the surrounding properties. The above section entitled **Erosion Hazard Areas** covers temporary erosion control measures that would be prudent. In preventing erosion control problems on any site, it is most important that any disturbed soil areas be immediately protected. This requires diligence and frequent communication on the part of the general contractor and earthwork subcontractor. As with all construction projects undertaken during potentially wet conditions, it is important that the contractor's on-site personnel are familiar with erosion control measures and that they monitor their performance on a regular basis. It is also appropriate for them to take immediate action to correct any erosion control problems that may develop, without waiting for input from the geotechnical engineer or representatives of the City.

All, or the vast majority, of the excavated soil will be unsuitable for reuse on the site. These soils will be silty and fine-grained. They have poor drainage characteristics and low compacted strength, and will present an erosion control problem. As a result, we expect that excavated soils will be hauled off the site, and imported granular fill will be needed for the project.

Due to the impervious nature of the on-site soils, and the presence of southern steep slope and the basement beneath the existing house, it is our professional opinion that on-site infiltration of runoff from impervious areas is infeasible. Collected water should be discharged to the storm drainage system.

The drainage and/or waterproofing recommendations presented in this report are intended only to prevent active seepage from flowing through concrete walls or slabs. Even in the absence of active seepage into and beneath structures, water vapor can migrate through walls, slabs, and floors from the surrounding soil, and can even be transmitted from slabs and foundation walls due to the concrete curing process. Water vapor also results from occupant uses, such as cooking, cleaning, and bathing. Excessive water vapor trapped within structures can result in a variety of undesirable conditions, including, but not limited to, moisture problems with flooring systems, excessively moist air within occupied areas, and the growth of molds, fungi, and other biological organisms that may be harmful to the health of the occupants. The designer or architect must consider the potential vapor sources and likely occupant uses, and provide sufficient ventilation, either passive or mechanical, to prevent a build up of excessive water vapor within the planned structure.

Geotech Consultants, Inc. should be allowed to review the final development plans to verify that the recommendations presented in this report are adequately addressed in the design. Such a plan review would be additional work beyond the current scope of work for this study, and it may include revisions to our recommendations to accommodate site, development, and geotechnical constraints that become more evident during the review process.

We recommend including this report, in its entirety, in the project contract documents. This report should also be provided to any future property owners so they will be aware of our findings and recommendations.

SEISMIC CONSIDERATIONS

In accordance with the International Building Code (IBC), the site class within 100 feet of the ground surface is best represented by Site Class Type D (Stiff Soil). As noted in the USGS website, the mapped spectral acceleration value for a 0.2 second (S_s) and 1.0 second period (S_1) equals 1.44g and 0.50g, respectively.

The IBC and ASCE 7 require that the potential for liquefaction (soil strength loss) during an earthquake be evaluated for the peak ground acceleration of the Maximum Considered Earthquake (MCE), which has a probability of occurring once in 2,475 years (2 percent probability of occurring in a 50-year period). The MCE peak ground acceleration adjusted for site class effects (F_{PGA}) equals 0.68g. The soils beneath the site are not susceptible to seismic liquefaction under the ground motions of the MCE because of their dense nature and the absence of near-surface groundwater.

CONVENTIONAL FOUNDATIONS

As discussed above, conventional continuous and spread footings bearing on native, undisturbed, dense to very dense glacial till can be used to support the proposed new basement garage. We recommend that continuous and individual spread footings have minimum widths of 12 and 16 inches, respectively. Exterior footings should also be bottomed at least 18 inches below the lowest adjacent finish ground surface for protection against frost and erosion. The local building codes should be reviewed to determine if different footing widths or embedment depths are required. Footing subgrades must be cleaned of loose or disturbed soil prior to pouring concrete. Depending upon site and equipment constraints, this may require removing the disturbed soil by hand.

Thickened slabs are often used to support interior walls. It is important to remember that thickened slab areas support building loads, just like conventional footings do. For this reason, the subgrade below thickened slabs must be prepared in the same way as for conventional footings. All unsuitable soils have to be removed and any structural fill compacted in accordance with the recommendations of this report. We recommend against the use of thickened slabs for most projects, particularly single-family residential, as it is difficult to ensure that the subgrades have been appropriately prepared. Also, the compacted slab fill has to be protected from disturbance by the earthwork, foundation, and utility contractors.

An allowable bearing pressure of 3,000 pounds per square foot (psf) is appropriate for footings supported on native, dense to very dense glacial till. A one-third increase in this design bearing pressure may be used when considering short-term wind or seismic loads. For the above design criteria, it is anticipated that the total post-construction settlement of footings founded on competent native soil, will be about one inch, with differential settlements on the order of one half-inch in a distance of 50 feet along a continuous footing with a uniform load.

Lateral loads due to wind or seismic forces may be resisted by friction between the foundation and the bearing soil, or by passive earth pressure acting on the vertical, embedded portions of the foundation. For the latter condition, the foundation must be either poured directly against relatively level, undisturbed soil or be surrounded by level, well-compacted fill. We recommend using the following ultimate values for the foundation's resistance to lateral loading:

PARAMETER	ULTIMATE VALUE
Coefficient of Friction	0.50
Passive Earth Pressure	300 pcf

Where: pcf is Pounds per Cubic Foot, and Passive Earth Pressure is computed using the Equivalent Fluid Density.

If the ground in front of a foundation is loose or sloping, the passive earth pressure given above will not be appropriate. The above ultimate values for passive earth pressure and coefficient of friction do not include a safety factor.

PIPE PILES

A 2-inch-diameter pipe pile driven with a minimum 90-pound jackhammer or a 140-pound Rhino hammer to a final penetration rate of 1-inch or less for one minute of continuous driving may be assigned an allowable compressive load of 3 tons. Extra-strong steel pipe should be used. The site soils are not highly organic, and are not located near salt water. As a result, they do not have an elevated corrosion potential. Considering this, it is our opinion that standard “black” pipe can be used, and corrosion protection, such as galvanizing, is not necessary for the pipe piles. Subsequent pipe sections should be connected together using threaded or slip couplers, or by welding. If slip couplers are used, they must fit snugly into the ends of the pipes. This can require that shims or beads of welding flux be applied to the couplers.

Pile caps and/or grade beams should be used to transmit loads to the piles. A minimum of two piles should be used in isolated pile caps, in order to prevent eccentric loading on individual piles. For added protection of the new foundations in the event of future shallow slope movement, we recommend that the piles supporting the bump out addition footings off the south side of the residence be supported on a minimum of two pipe piles, with one of the piles being battered down toward the south at a 1:5 (H:V) inclination.

Lateral loads may are typically resisted by passive earth pressure acting on the vertical, embedded portions of the foundation. However, due to the ground surface sloping away from the southern edge of the residence, no passive pressure should be accounted for against the pile caps/grade beams for the southern bump out addition. Due to their small diameter, the lateral capacity of vertical pipe piles is negligible. Lateral resistance may be achieved by driving battered piles in the same direction as the applied lateral load. The lateral capacity of a battered pile is equal to one-half of the lateral component of the allowable compressive load, with a maximum allowable lateral capacity of 500 pounds. The allowable vertical capacity of battered piles does not need to be reduced if the piles are battered steeper than 1:5 (Horizontal:Vertical).

It is difficult to accurately estimate the length that the piles will need to be driven to achieve the recommended refusal rate. However, we do recommend that the piles be driven to a minimum embedment of 7 feet below the existing grade. It is likely that the piles will extend deeper than this minimum length.

FOUNDATION AND RETAINING WALLS

Retaining walls backfilled on only one side should be designed to resist the lateral earth pressures imposed by the soil they retain. The following recommended parameters are for walls that restrain <u>level</u> backfill:

PARAMETER	VALUE
Active Earth Pressure *	35 pcf
Passive Earth Pressure	300 pcf
Coefficient of Friction	0.50
Soil Unit Weight	130 pcf

Where: pcf is Pounds per Cubic Foot, and Active and Passive Earth Pressures are computed using the Equivalent Fluid Pressures.

*** For a restrained wall that cannot deflect at least 0.002 times its height, a uniform lateral pressure equal to 10 psf times the height of the wall should be added to the above active equivalent fluid pressure. This applies only to walls with level backfill.**

The design values given above do not include the effects of any hydrostatic pressures behind the walls and assume that no surcharges, such as those caused by slopes, vehicles, or adjacent foundations will be exerted on the walls. If these conditions exist, those pressures should be added to the above lateral soil pressures. The existing site retaining wall north of the proposed residence and covered walkway will likely place a surcharge onto the proposed structures' northern foundation walls. We can provide appropriate surcharge loads once more detailed plans have been developed. It may be possible for the excavation shoring to be designed to withstand this surcharge. Where sloping backfill is desired behind the walls, we will need to be given the wall dimensions and the slope of the backfill in order to provide the appropriate design earth pressures. The surcharge due to traffic loads behind a wall can typically be accounted for by adding a uniform pressure equal to 2 feet multiplied by the above active fluid density. Heavy construction equipment should not be operated behind retaining and foundation walls within a distance equal to the height of a wall, unless the walls are designed for the additional lateral pressures resulting from the equipment.

The values given above are to be used to design only permanent foundation and retaining walls that are to be backfilled, such as conventional walls constructed of reinforced concrete or masonry. It is not appropriate to use the above earth pressures and soil unit weight to back-calculate soil strength parameters for design of other types of retaining walls, such as soldier pile, reinforced earth, modular or soil nail walls. We can assist with design of these types of walls, if desired.

The passive pressure given is appropriate only for a shear key poured directly against undisturbed native soil, or for the depth of level, well-compacted fill placed in front of a retaining or foundation wall. The values for friction and passive resistance are ultimate values and do not include a safety factor. Restrained wall soil parameters should be utilized the wall and reinforcing design for a distance of 1.5 times the wall height from corners or bends in the walls, or from other points of restraint. This is intended to reduce the amount of cracking that can occur where a wall is restrained by a corner.

<u>Wall Pressures Due to Seismic Forces</u>

The surcharge wall loads that could be imposed by the design earthquake can be modeled by adding a uniform lateral pressure to the above-recommended active pressure. The recommended surcharge pressure is 8**H** pounds per square foot (psf), where **H** is the design retention height of the wall. Using this increased pressure, the safety factor against sliding and overturning can be reduced to 1.2 for the seismic analysis.

<u>Retaining Wall Backfill and Waterproofing</u>

Backfill placed behind retaining or foundation walls should be coarse, free-draining structural fill containing no organics. This backfill should contain no more than 5 percent silt or clay particles and have no gravel greater than 4 inches in diameter. The percentage of particles passing the No. 4 sieve should be between 25 and 70 percent. The on-site soils are not free-draining, and should not be reused as wall backfill. For increased protection, drainage composites should be placed along cut slope faces, and the walls should be backfilled entirely with free-draining soil. The later section entitled ***Drainage Considerations*** should also be reviewed for recommendations related to subsurface drainage behind foundation and retaining walls.

The purpose of these backfill requirements is to ensure that the design criteria for a retaining wall are not exceeded because of a build-up of hydrostatic pressure behind the wall. Also, subsurface drainage systems are not intended to handle large volumes of water from surface runoff. The top 12 to 18 inches of the backfill should consist of a compacted, relatively impermeable soil or topsoil, or the surface should be paved. The ground surface must also slope away from backfilled walls at one to 2 percent to reduce the potential for surface water to percolate into the backfill.

Water percolating through pervious surfaces (pavers, gravel, permeable pavement, etc.) must also be prevented from flowing toward walls or into the backfill zone. Foundation drainage and waterproofing systems are not intended to handle large volumes of infiltrated water. The compacted subgrade below pervious surfaces and any associated drainage layer should therefore be sloped away. Alternatively, a membrane and subsurface collection system could be provided below a pervious surface.

It is critical that the wall backfill be placed in lifts and be properly compacted, in order for the above-recommended design earth pressures to be appropriate. The recommended wall design criteria assume that the backfill will be well-compacted in lifts no thicker than 12 inches. The compaction of backfill near the walls should be accomplished with hand-operated equipment to prevent the walls from being overloaded by the higher soil forces that occur during compaction. The section entitled ***General Earthwork and Structural Fill*** contains additional recommendations regarding the placement and compaction of structural fill behind retaining and foundation walls.

The above recommendations are not intended to waterproof below-grade walls, or to prevent the formation of mold, mildew or fungi in interior spaces. Over time, the performance of subsurface drainage systems can degrade, subsurface groundwater flow patterns can change, and utilities can break or develop leaks. Therefore, waterproofing should be provided where future seepage through the walls is not acceptable. This typically includes limiting cold-joints and wall penetrations, and using bentonite panels or membranes on the outside of the walls. There are a variety of different waterproofing materials and systems, which should be installed by an experienced contractor familiar with the anticipated construction and subsurface conditions. Applying a thin coat of asphalt emulsion to the outside face of a wall is not considered waterproofing, and will only help to reduce moisture generated from water vapor or capillary action from seeping through the concrete. As with any project, adequate ventilation of basement and crawl space areas is important to prevent a buildup of water vapor that is commonly transmitted through concrete walls from the surrounding soil, even when seepage is not present. This is appropriate even when waterproofing is applied to the outside of foundation and retaining walls. We recommend that you contact an experienced envelope consultant if detailed recommendations or specifications related to waterproofing design, or minimizing the potential for infestations of mold and mildew are desired.

The ***General***, ***Floor Slabs***, and ***Drainage Considerations*** sections should be reviewed for additional recommendations related to the control of groundwater and excess water vapor for the anticipated construction.

SLABS-ON-GRADE

The new floors can be constructed as slabs-on-grade atop non-organic native soil, or on structural fill. The subgrade soil must be in a firm, non-yielding condition at the time of slab construction. Any soft areas encountered should be excavated and replaced with select, imported structural fill.

Even where the exposed soils appear dry, water vapor will tend to naturally migrate upward through the soil to the new constructed space above it. This can affect moisture-sensitive flooring, cause imperfections or damage to the slab, or simply allow excessive water vapor into the space above the slab. All interior slabs-on-grade should be underlain by a capillary break drainage layer consisting of a minimum 4-inch thickness of clean gravel or crushed rock that has a fines content (percent passing the No. 200 sieve) of less than 3 percent and a sand content (percent passing the No. 4 sieve) of no more than 10 percent. Pea gravel or crushed rock are typically used for this layer.

As noted by the American Concrete Institute (ACI) in the *Guides for Concrete Floor and Slab Structures*, proper moisture protection is desirable immediately below any on-grade slab that will be covered by tile, wood, carpet, impermeable floor coverings, or any moisture-sensitive equipment or products. ACI recommends a minimum 10-mil thickness vapor retarder for better durability and long term performance than is provided by 6-mil plastic sheeting that has historically been used. A vapor retarder is defined as a material with a permeance of less than 0.3 perms, as determined by ASTM E 96. It is possible that concrete admixtures may meet this specification, although the manufacturers of the admixtures should be consulted. Where vapor retarders are used under slabs, their edges should overlap by at least 6 inches and be sealed with adhesive tape. The sheeting should extend to the foundation walls for maximum vapor protection.

If no potential for vapor passage through the slab is desired, a vapor *barrier* should be used. A vapor barrier, as defined by ACI, is a product with a water transmission rate of 0.01 perms when tested in accordance with ASTM E 96. Reinforced membranes having sealed overlaps can meet this requirement.

We recommend that the contractor, the project materials engineer, and the owner discuss these issues and review recent ACI literature and ASTM E-1643 for installation guidelines and guidance on the use of the protection/blotter material.

The ***General***, ***Foundation and Retaining Walls***, and ***Drainage Considerations*** sections should be reviewed for additional recommendations related to the control of groundwater and excess water vapor for the anticipated construction.

EXCAVATIONS AND SLOPES

Temporary excavation slopes should not exceed the limits specified in local, state, and national government safety regulations. Also, temporary cuts should be planned to provide a minimum 2 to 3 feet of space for construction of foundations, walls, and drainage. Unless approved by the geotechnical engineer of record, it is important that vertical cuts not be made at the base of sloped cuts. Based upon Washington Administrative Code (WAC) 296, Part N, the near-surface loose to medium-dense fill and native soils beneath the subject site would generally be classified as Type B. Therefore, temporary cut slopes greater than 4 feet in height should not be excavated at an inclination steeper than 1:1 (Horizontal:Vertical), extending continuously between the top and the bottom of a cut. The dense to very dense underlying glacial till would be classified as Type A. Therefore, a maximum 4-foot-tall cut **<u>in the dense glacial till</u>** may be used at the toe of a 1:1 (Horizontal:Vertical) cut slope. **<u>However,</u>** additional recommendations located in the ***General*** section should be reviewed regarding temporary cuts and excavation shoring for the proposed basement garage.

The above-recommended temporary slope inclination is based on the conditions exposed in our explorations, and on what has been successful at other sites with similar soil conditions. It is possible that variations in soil and groundwater conditions will require modifications to the inclination at which temporary slopes can stand. Temporary cuts are those that will remain unsupported for a relatively short duration to allow for the construction of foundations, retaining walls, or utilities. Temporary cut slopes should be protected with plastic sheeting during wet weather. It is also important that surface runoff be directed away from the top of temporary slope cuts. Cut slopes should also be backfilled or retained as soon as possible to reduce the potential for instability. Please note that sand or loose soil can cave suddenly and without warning. Excavation, foundation, and utility contractors should be made especially aware of this potential danger. These recommendations may need to be modified if the area near the potential cuts has been disturbed in the past by utility installation, or if settlement-sensitive utilities are located nearby.

All permanent cuts into native soil should be inclined no steeper than 2:1 (H:V). Fill slopes should not be constructed with an inclination greater than 2.5:1 (H:V). To reduce the potential for shallow sloughing, fill must be compacted to the face of these slopes. This can be accomplished by overbuilding the compacted fill and then trimming it back to its final inclination. Adequate compaction of the slope face is important for long-term stability and is necessary to prevent excessive settlement of patios, slabs, foundations, or other improvements that may be placed near the edge of the slope.

Water should not be allowed to flow uncontrolled over the top of any temporary or permanent slope. All permanently exposed slopes should be seeded with an appropriate species of vegetation to reduce erosion and improve the stability of the surficial layer of soil.

ULTRABLOCK SHORING

Cuts of up to a 7-foot vertical exposed height may be temporarily supported by ultra-block shoring. An ultrablock is a precast 2.5-foot-square concrete block with lengths of 5 feet. The blocks can be stacked using an integral ridge along the top of the block that fits a like indentation in the bottom of the blocks above. The blocks should be stacked in a staggered brickwork pattern such that each block above interlocks with two blocks below. This may require the use of half-width blocks. The blocks may be stacked vertically, provided at least one “return” block is used at the eastern end of the wall. The base of the block wall should rest on the dense, glacial till and the base block should be buried at least 6 inches below the bottom-of-excavation grade. The annular space behind the blocks should be filled with clean crushed rock (i.e. 2-inch ballast) for drainage. The excavation at the face of the base of the blocks (backfill of the embedded ‘key’ below the bottom of excavation) should be backfilled with compacted crushed rock. Temporary near-vertical cuts will be necessary to install the blocks. We recommend that all of the materials for constructing the wall (blocks and rock) be onsite prior to the excavation for the wall. The wall should be constructed in segments (on the order of 10 feet long) with the blocks being stacked and backfilled immediately after excavation is complete. No excavated sections should be left open overnight. This “build as you go” technique will minimize the exposure of the adjacent soils to sloughing. A 1:1 (H:V) slope above the block may be established with the backfill rock. A Temporary Ultrablock Shoring Detail is attached to this report as Plate 5.

EXCAVATION AND SHORING MONITORING

As with any shoring system, there is a potential risk of greater-than-anticipated movement of the shoring and the ground outside of the excavation. This can translate into noticeable damage of surrounding on-grade elements, such as foundations and slabs. Therefore, we recommend making an extensive photographic and visual survey of the project vicinity, prior to demolition activities, installing shoring or commencing excavation. This documents the condition of buildings, pavements, and utilities in the immediate vicinity of the site in order to avoid, and protect the owner from, unsubstantiated damage claims by surrounding property owners.

Additionally, the shoring walls and any adjacent foundations should be monitored during construction to detect soil movements. To monitor their performance, we recommend establishing a series of survey reference points to measure any horizontal deflections of the shoring system. Control points should be established at a distance well away from the walls and slopes, and deflections from the reference points should be measured throughout construction by survey methods. At least every other soldier pile should be monitored by taking readings at the top of the pile. Additionally, benchmarks installed on the surrounding buildings should be monitored for at least vertical movement. We suggest taking the readings at least once a week, until it is established that no deflections are occurring. The initial readings for this monitoring should be taken before starting any demolition or excavation on the site.

DRAINAGE CONSIDERATIONS

We anticipate that permanent foundation walls may be constructed against the shoring walls. Where this occurs, a plastic-backed drainage composite, such as Miradrain, Battledrain, or similar, should be placed against the entire surface of the shoring prior to pouring the foundation wall. Weep pipes located no more than 6 feet on-center should be connected to the drainage composite and poured into the foundation walls or the perimeter footing. A footing drain installed along the inside of the perimeter footing will be used to collect and carry the water discharged by the weep pipes to the storm system. Isolated zones of moisture or seepage can still reach the permanent wall where groundwater finds leaks or joints in the drainage composite. This is often an acceptable risk in unoccupied below-grade spaces, such as parking garages. However, formal waterproofing is typically necessary in areas where wet conditions at the face of the permanent wall will not be tolerable. If this is a concern, the permanent drainage and waterproofing system should be designed by a specialty consultant familiar with the expected subsurface conditions and proposed construction. Plate 5 presents typical considerations for foundation drains at shoring walls.

Footing drains placed inside the building, outside of the building, or behind backfilled walls should consist of 4-inch, perforated PVC pipe surrounded by at least 6 inches of 1-inch-minus, washed rock wrapped in a non-woven, geotextile filter fabric (Mirafi 140N, Supac 4NP, or similar material). At its highest point, a perforated pipe invert should be at least 6 inches below the level of a crawl space or the bottom of a floor slab, and it should be sloped slightly for drainage. All roof and surface water drains must be kept separate from the foundation drain system.

Footing drains outside of the building should be used where: (1) crawl spaces or basements will be below a structure; (2) a slab is below the outside grade; or, (3) the outside grade does not slope downward from a building. A typical footing drain detail is attached to this report as Plate 6. Clean-outs should be provided for potential future flushing or cleaning of footing drains.

As a minimum, a vapor retarder, as defined in the ***Slabs-on-Grade*** section, should be provided in any crawl space area to limit the transmission of water vapor from the underlying soils. Crawl space grades are sometimes left near the elevation of the bottom of the footings. As a result, an outlet drain is recommended for all crawl spaces to prevent an accumulation of any water that may bypass the footing drains. Providing a few inches of free draining gravel underneath the vapor retarder is also prudent to limit the potential for seepage to build up on top of the vapor retarder.

Perched groundwater was observed during our field work. If seepage is encountered in an excavation, it should be drained from the site by directing it through drainage ditches, perforated pipe, or French drains, or by pumping it from sumps interconnected by shallow connector trenches at the bottom of the excavation.

The excavation and site should be graded so that surface water is directed off the site and away from the tops of slopes. Water should not be allowed to stand in any area where foundations, slabs, or pavements are to be constructed. Final site grading in areas adjacent to a building should slope away at least one to 2 percent, except where the area is paved. Surface drains should be provided where necessary to prevent ponding of water behind foundation or retaining walls. A discussion of grading and drainage related to pervious surfaces near walls and structures is contained in the ***Foundation and Retaining Walls*** section.

GENERAL EARTHWORK AND STRUCTURAL FILL

All building and pavement areas should be stripped of surface vegetation, topsoil, organic soil, and other deleterious material. The stripped or removed materials should not be mixed with any materials to be used as structural fill, but they could be used in non-structural areas, such as landscape beds.

Structural fill is defined as any fill, including utility backfill, placed under, or close to, a building, or in other areas where the underlying soil needs to support loads. All structural fill should be placed in horizontal lifts with a moisture content at, or near, the optimum moisture content. The optimum moisture content is that moisture content that results in the greatest compacted dry density. The moisture content of fill is very important and must be closely controlled during the filling and compaction process. As discussed in the ***General*** section, the native on-site soils are not suitable for reuse as structural fill, due to their high fines content and moisture sensitivity. The onsite gravelly, slightly silty sand fill soils could potentially be re-used as structural fill provided they can be placed and compacted near their optimum moisture content.

Fills placed on sloping ground should be keyed into the medium-dense to dense native soils. This is typically accomplished by placing and compacting the structural fill on level benches that are cut into the competent soils. The allowable thickness of the fill lift will depend on the material type selected, the compaction equipment used, and the number of passes made to compact the lift. The loose lift thickness should not exceed 12 inches, but should be thinner if small, hand-operated compactors are used. We recommend testing structural fill as it is placed. If the fill is not sufficiently compacted, it should be recompacted before another lift is placed. This eliminates the need to remove the fill to achieve the required compaction. The following table presents recommended levels of relative compaction for compacted fill:

LOCATION OF FILL PLACEMENT	MINIMUM RELATIVE COMPACTION
Beneath slabs or walkways	95%
Filled slopes and behind retaining walls	90%
Beneath pavements	95% for upper 12 inches of subgrade; 90% below that level

Where: Minimum Relative Compaction is the ratio, expressed in percentages, of the compacted dry density to the maximum dry density, as determined in accordance with ASTM Test Designation D 1557-91 (Modified Proctor).

Structural fill that will be placed in wet weather should consist of a coarse, granular soil with a silt or clay content of no more than 5 percent. The percentage of particles passing the No. 200 sieve should be measured from that portion of soil passing the three-quarter-inch sieve.

LIMITATIONS

The conclusions and recommendations contained in this report are based on site conditions as they existed at the time of our exploration and assume that the soil and groundwater conditions encountered in the subsurface explorations are representative of subsurface conditions on the site. If the subsurface conditions encountered during construction are significantly different from those observed in our explorations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. Unanticipated conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking samples in test borings and test holes. Subsurface conditions can also vary between exploration locations. Such unexpected conditions frequently require making additional expenditures to attain a properly constructed project. It is recommended that the owner consider providing a contingency fund to accommodate such potential extra costs and risks. This is a standard recommendation for all projects.

This report has been prepared for the exclusive use of Kam Derakshani and his representatives, for specific application to this project and site. Our conclusions and recommendations are professional opinions derived in accordance with our understanding of current local standards of practice, and within the scope of our services. No warranty is expressed or implied. The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. Our services also do not include assessing or minimizing the potential for biological hazards, such as mold, bacteria, mildew and fungi in either the existing or proposed site development.

ADDITIONAL SERVICES

In addition to reviewing the final plans, Geotech Consultants, Inc. should be retained to provide geotechnical consultation, testing, and observation services during construction. This is to confirm that subsurface conditions are consistent with those indicated by our exploration, to evaluate whether earthwork and foundation construction activities comply with the general intent of the recommendations presented in this report, and to provide suggestions for design changes in the event subsurface conditions differ from those anticipated prior to the start of construction. However, our work would not include the supervision or direction of the actual work of the contractor and its employees or agents. Also, job and site safety, and dimensional measurements, will be the responsibility of the contractor.

The recommendations presented in this report are measures to keep the proposed additions from negatively impacting the slope stability. Predicting the future behavior of steep slopes and the potential effects of development on their stability is an inexact and imperfect science that is currently based mostly on the past behavior of slopes with similar characteristics. Landslides and soil movement can occur on steep slopes before, during, or after the development of property. At additional cost, we can provide recommendations for reducing the risk of future movement on the steep slopes, which could involve regrading the slopes or installing subsurface drains or costly retaining structures. However, the owner must ultimately accept the possibility that some slope movement could occur, resulting in possible loss of ground or damage to the existing and proposed of the existing residence.

During the construction phase, we will provide geotechnical observation and testing services when requested by you or your representatives. Please be aware that we can only document site work we actually observe. It is still the responsibility of your contractor or on-site construction team to verify that our recommendations are being followed, whether we are present at the site or not.

The following plates are attached to complete this report:

Plate 1	Vicinity Map
Plate 2	Site Exploration Plan
Plates 3 - 4	Test Boring Logs
Plate 5	Temporary Ultrablock Shoring Detail
Plate 6	Typical Footing Drain Detail

We appreciate the opportunity to be of service on this project. Please contact us if you have any questions, or if we can be of further assistance.

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

3/29/21

Adam S. Moyer
Geotechnical Engineer

James H. Strange, Jr., P.E.
Associate

ASM/JHS:kg

NORTH

(Source: Microsoft MapPoint, 2013)

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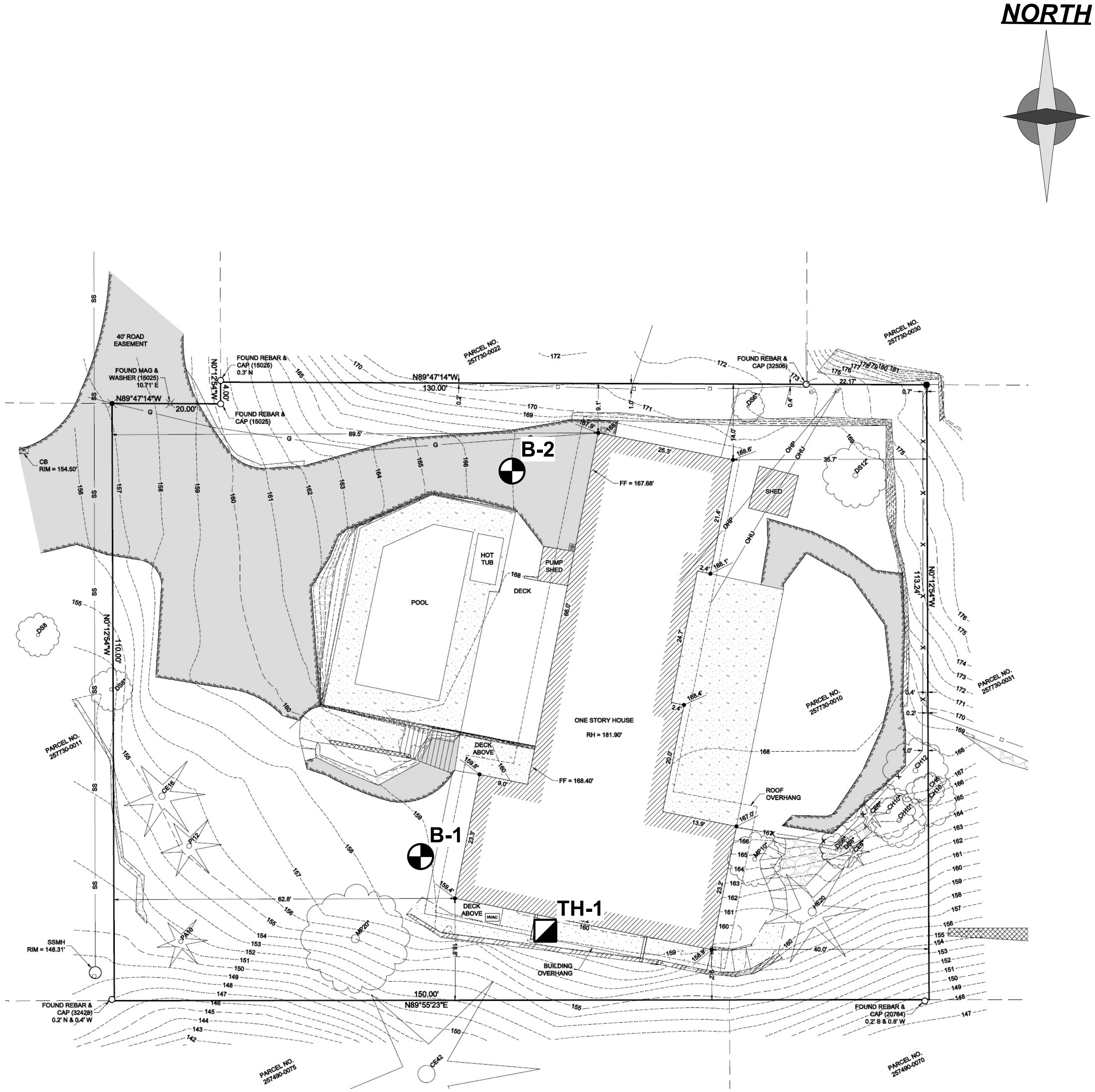
VICINITY MAP

8151 Southeast 48th Street
Mercer Island, Washington

Job No:	Date:		Plate:
21062	Mar. 2021		1



Legend:

- Test Boring Location
- Test Hole Location

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SITE EXPLORATION PLAN

8151 Southeast 48th Street
Mercer Island, Washington

Job No:	Date:		Plate:
21062	Mar. 2021	No Scale	2

BORING 1

Depth (ft.)	Moisture	Water Table	Blows per Foot	Sample	USCS	Description (Elevation ±159 feet)
					FILL	Topsoil over dark-brown gravelly silty SAND, fine- to medium-grained, moist, loose **(FILL)**
						Reddish-brown silty SAND with gravel, fine- to medium-grained, moist, loose
			14	1		-becomes brown with rust mottling, very moist, medium-dense
5			20	2		-becomes gray-brown with rust mottling, fine-grained, moist, with occasional thin sand seams
			37	3		-becomes gray, slightly cemented, dense **(Glacial Till)**
10		▽	50	4	SM	-with 4-inch wet medium-grained sand seam
15			33	5		-with occasional sandy and silt seams
20		▽	39	6		-with 2-inch wet sand seam

*** Test boring was terminated at 21.5 feet on March 4, 2021.**

*** Thin perched groundwater seams was encountered at 11 and 21 feet during drilling.**

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TEST BORING LOG

8151 Southeast 48th Street
Mercer Island, Washington

Job No:	Date:	Logged by:	Plate:
21062	Mar. 2021	ASM	3

BORING 2

Elevation ±167 feet

Depth (ft.)	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
					FILL	3-inches of asphalt over: Brown gravelly SAND, fine- to coarse-grained, dry, medium-dense **(FILL)**
						Reddish-brown silty SAND with gravel, fine- to medium-grained, moist, loose
			29	1	SM	-becomes gray-brown, very moist, medium-dense to dense **(Glacial Till)** with occasional sandy seams -becomes moist
5			28	2	SP	Gray-brown SAND with trace silt, fine- to medium-grained, very moist to wet, medium-dense to dense
			50/2"	3		Gray-brown gravelly silty SAND with occasional silt and sand seams, fine-grained, moist, very dense **(Glacial Till)**
10					SM	
			86	4		
			52	5		
15						
20						

* **Test boring was terminated at 13 feet on March 4, 2021.**

* **Perched groundwater was encountered from 5 to 6.5 feet during drilling.**

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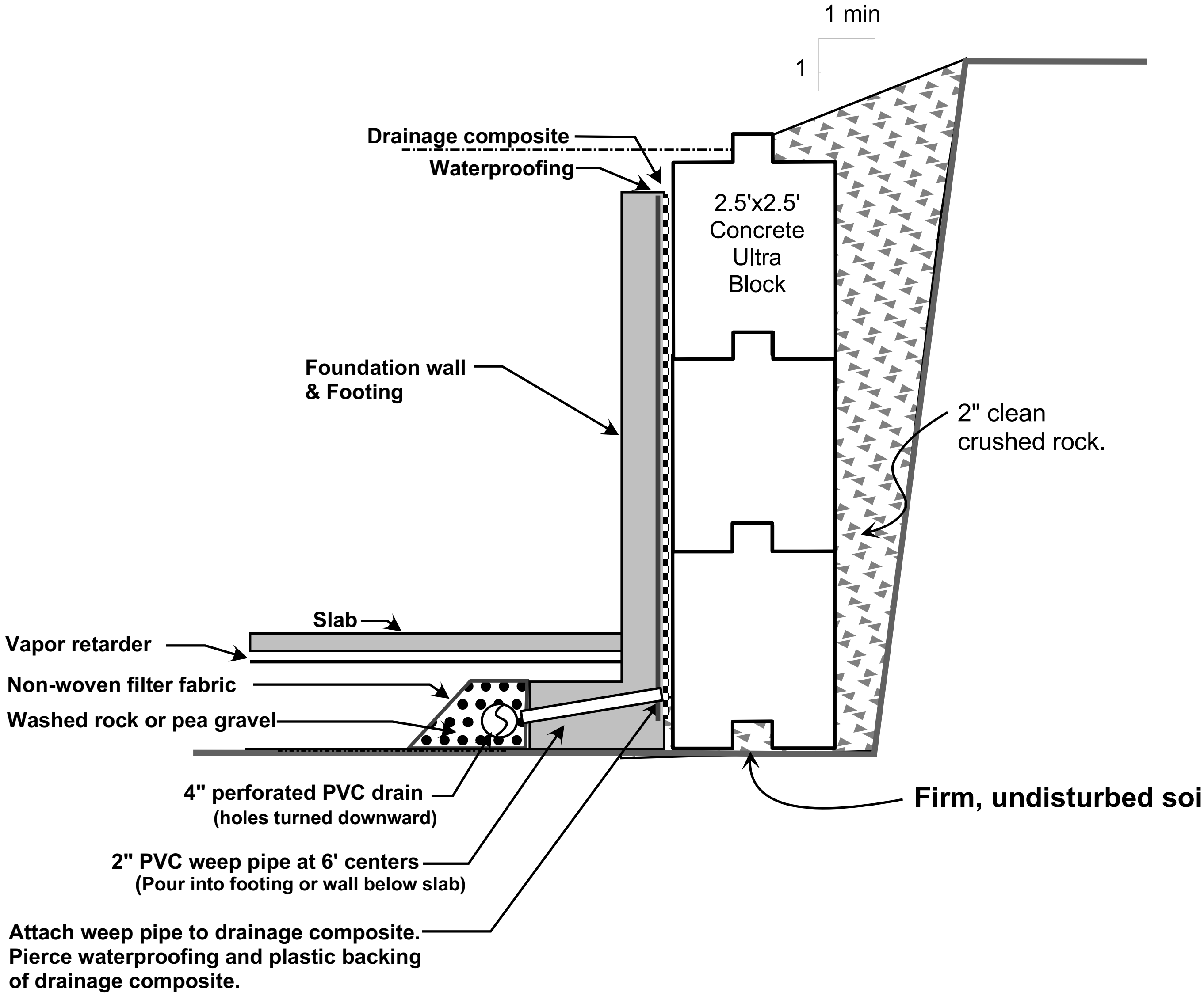
TEST BORING LOG

8151 Southeast 48th Street
Mercer Island, Washington

Job No:	Date:	Logged by:	Plate:
21062	Mar. 2021	ASM	4



General Notes

1) Each Ultra Block should bear on two blocks in the tier below to interlock the blocks.

2) All material (blocks and rock backfill) shall be on site and ready for placement prior to excavation for the wall such that the wall can be excavated, placed and backfilled immediately.

3) The block wall shall return with interlock at least 1 block length at the southern end end of the wall for stability.

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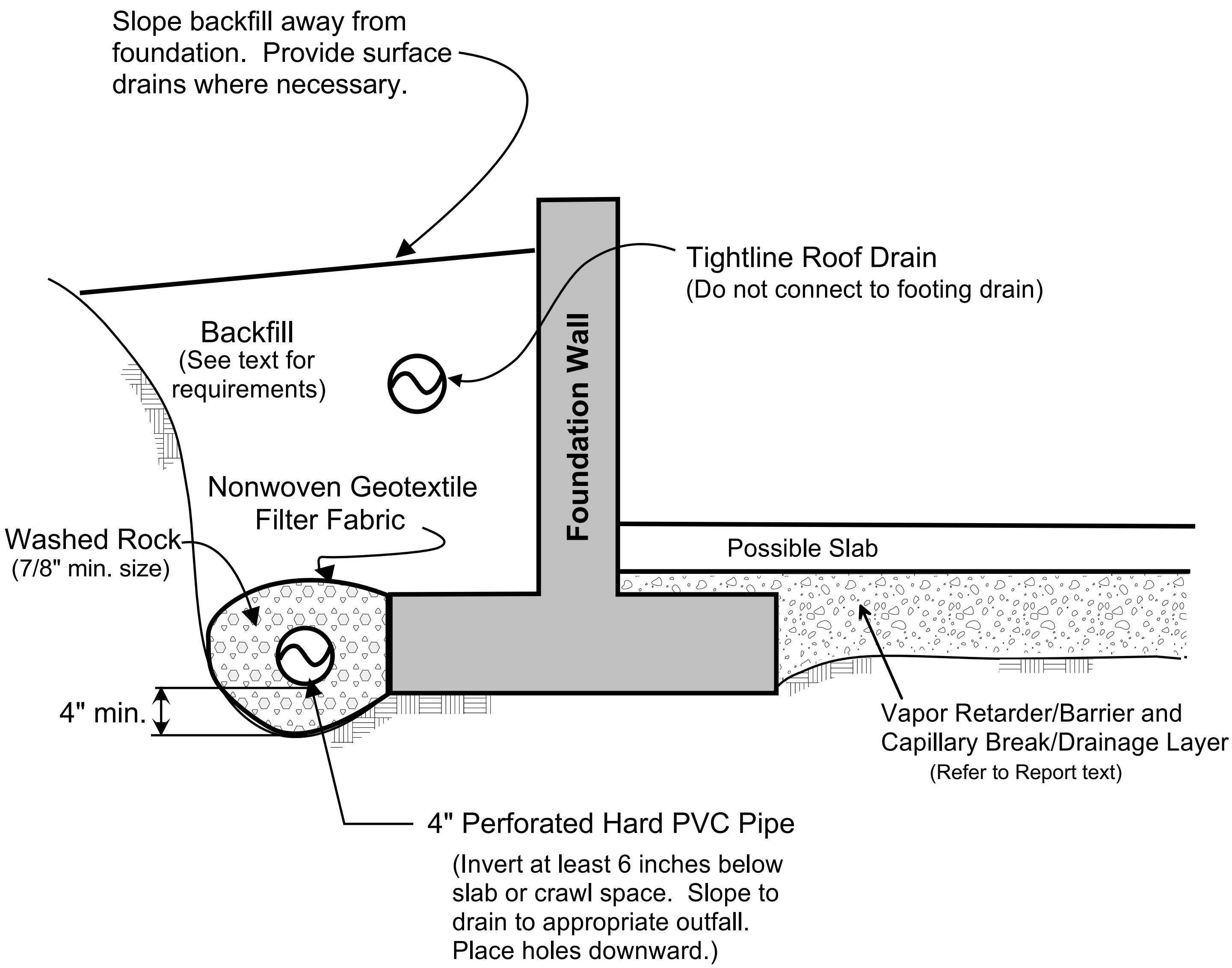
TEMPORARY ULTRA BLOCK SHORING DETAIL

8151 Southeast 48th Street
Mercer Island, Washington

Job No:	Date:		Plate:
21062	Mar. 2021		5



NOTES:

(1) In crawl spaces, provide an outlet drain to prevent buildup of water that bypasses the perimeter footing drains.

(2) Refer to report text for additional drainage, waterproofing, and slab considerations.

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FOOTING DRAIN DETAIL

8151 Southeast 48th Street
Mercer Island, Washington

Job No:	Date:		Plate:
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