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June 7, 2021

JN 21165

Sharon Nguyen
9831 Southeast 42nd Place
Mercer Island, Washington
via email: sharon_win@mac.com

Subject: **Transmittal Letter – Geotechnical Engineering Study and Critical Area Study**
Proposed New Residence
9831 Southeast 42nd Place
Mercer Island, Washington

Dear Ms. Nguyen,

Attached to this transmittal letter is our geotechnical engineering report for the proposed residence to be constructed 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 and design considerations for foundations, retaining walls, critical areas, subsurface drainage, and temporary excavations and shoring. This work was authorized by your acceptance of our proposal, P-10866, dated April 8, 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.

Matthew K. McGinnis
Geotechnical Engineer

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Principal

MKM/MRM:kg

GEOTECHNICAL ENGINEERING STUDY
Proposed New Residence
9831 Southeast 42nd Place
Mercer Island, Washington

This report presents the findings and recommendations of our geotechnical engineering study for the site of the proposed residence to be located in Mercer Island.

Development of the property is still in the planning stage, and detailed plans were not available at the time of writing this report. We were provided with a topographic survey prepared by Site Surveying, Inc., dated June 20, 2016. We were also provided with a sketch showing the approximate outline of a proposed residence overlain on the survey. Based on this information, and our discussions with Sharon Nguyen, we understand that a new, larger residence is proposed to be constructed at the site in place of the existing residence, which will be demolished. The new residence will likely be two stories in height and will be underlain by a basement which will daylight to the south towards Lake Washington. The new house footprint may be shifted further to the south from that of the current residence. The existing driveway will be used for access, and a new garage will be constructed along the north side of the new house. The southward shift of the house's footprint could provide a larger motorcourt. Also, the north wall of the house may be extended above the existing motorcourt grade so that fill can be placed, lessening the grade of the lower portion of the driveway. We would anticipate that a multi-story deck will extend off the southern side of the house, and a patio space will be constructed at the level of the daylight basement. No finish floor elevations or property line setbacks have been developed at this time, but we anticipate that the new residence will have its main floor and basement slab located close to the floor elevations of the existing house.

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 eastern side of Mercer Island. The irregularly-shaped site comprises a total site area of approximately 0.36-acres. The property is bordered to the north by Southeast 42nd Place, to the east and west by single-family parcels, and to the south by Lake Washington.

The grade across the site slopes downward from north to south, with a total elevation change of approximately 38 feet across the lot. Initially, the grade drops steeply downward from the level of Southeast 42nd Place. This initial slope is inclined at 50 to 60 percent, over total elevation changes of 16 to 18 feet. A 2 to 5-foot-tall rockery lines the base of this slope, and delineates the northern alignment of the concrete driveway, which extends across this slope from the street. A large, relatively flat concrete motorcourt area is set at the base of the driveway, to the north of the existing residence. The grade drops moderately across the residence footprint from the northern, main level to the lower, south-facing daylight basement. Some small landscaping features and rockeries exist in these side yard areas to facilitate the step-down in grade. An above grade deck extends off the south side of the main level of the house, and a small patio is set beneath the deck. The remainder of the southern portion of the property is sloped gently, continuing out across a large grass yard area to the shore of Lake Washington.

The City of Mercer Island GIS indicates that the site is mapped within a Potential Landslide Hazard Area. The site is also mapped to include an Erosion Hazard Area and Seismic Hazard Area.

The adjacent eastern and western properties are both developed with single-family residences. The eastern property (#9827) contains an older, one-story residence with a daylight basement. This residence appears to have been constructed at a similar elevation to the subject site and is set greater than 10 feet from the property line. However, a large garage/shed is set within a few feet of the property line, near the northeastern corner of the existing residence. This structure appeared to be in poor condition and is likely constructed atop a foundation system located near the ground surface. The adjacent western property is developed with a renovated, two-story residence underlain by a south facing daylight basement. At its closest point, this residence is set approximately 4 feet from the northwestern edge of the subject site's driveway. This section of the residence appears to be garage space and is not underlain by a basement. Most of the site grade on the adjacent lot is set a few feet above the grade of the subject site.

SUBSURFACE

The subsurface conditions on the site were explored by drilling three test borings 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 borings were drilled on May 21, 2021 using a small, rubber tracked drill rig and a portable Acker drill. The Acker drill system utilizes a small, gasoline-powered engine to advance a hollow-stem auger to the sampling depth and can be hand-carried into sites with very limited access. Samples were taken at approximate 2.5 and 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 through 5.

Soil Conditions

Test Boring 1 was drilled just north of the existing house, on the upslope, northern side of the proposed residence location, using the larger, more powerful tracked drill. Beneath the ground surface, a layer of medium-dense fill soil was encountered. This fill layer extended to a depth of around 7 feet and was likely placed after the basement walls of the current house were backfilled. Beneath the fill, native, medium-dense, weathered silt was encountered. This upper layer of silt was underlain by a thin layer of medium-dense, slightly silty sand at a depth of 12 feet. Very stiff, glacially-compressed silt was revealed beneath the slightly silty sand layer at a depth of 14 feet. This silt layer continued with depth, becoming hard and massive beneath a depth of 25 feet. This hard silt layer continued to the base of the boring at a depth of 36.5 feet.

Test Boring 2 was drilled near the southern extent of the proposed development, and Test Boring 3 was drilled near the basement patio extending off the existing house. Both were drilled with the smaller, Acker drill due to access limitations. Beneath the ground surface, native, loose sand and slightly silty sand were encountered. The sand and slightly silty sand layers continued with depth, becoming medium-dense beneath depths of 5 feet, and dense (glacially-compressed) beneath depths of 7.5 to 10 feet. These dense soils continued to the base of the test borings at depths of 10.5 to 16.5 feet where auger refusal was met.

No obstructions were revealed by our on-site explorations. Although our explorations did not encounter cobbles or boulders, they are often found in soils that have been deposited by glaciers or fast-moving water.

Groundwater Conditions

Groundwater seepage was observed at a depth of 12.5 feet in Test Boring 3 during drilling. It should be noted that groundwater levels vary seasonally with rainfall and other factors. We anticipate that groundwater could be found in more permeable soil layers and perched between the looser near-surface soil and the underlying silt.

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 AREA STUDY (MICC 19.07)

Seismic Hazard Areas: The entire subject site is located within a mapped Seismic Hazard Area. This is noted on the attached Site Exploration Plan. The soils beneath the site are not susceptible to seismic liquefaction under the ground motions of a potential large earthquake either because of their glacially-compressed nature or the absence of near-surface groundwater. In addition, the foundations for the new construction will be supported on pipe piles embedded in to the underlying dense, non-liquefiable soils, which will mitigate any potential Seismic Hazard, whether present or not.

Landslide Hazard Areas: There are several criteria for being a Landslide Hazard Area based on the MICC. The first of several criteria are as follow:

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 overlying a relatively impermeable sediment or bedrock; and
   c. 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.

In our professional opinion, none of these criteria are met within the subject site.

There is a fifth criteria with regards to Landslide Hazard areas: Any slope that is 40 percent or greater measured over a 30-foot horizontal run (Steep Slope). As noted earlier, there is an approximate 16 to 18-foot-tall Steep Slope on the northern side of the property, which is inclined from 50 to 60 percent. This slope has obviously been created during previous grading associated with construction of the existing driveway, and possibly Southeast 42nd Place. The original slope was likely cut to its oversteepened condition during this time, and the rockery was likely cut into the toe of the slope during the lot grading. While this slope does exist, the soils encountered in our test borings would indicate that the core of the site consists of glacially compressed soils, which are not susceptible to deep-seated landslides. However, there always exists at least some potential for future shallow landslides to occur within the upper few feet of steep slopes as the upper soils become weathered and saturated with water following extended periods of rainfall. Based on MICC 19.07.160, for Steep Slope Landslide Hazard Areas whose only potential is a shallow landslide, this prescriptive buffer is 25 feet. At this time, we are not aware that any alteration from the prescriptive buffers will be needed for the project, given the preliminary siting location placing the northern edge of the residence outside of the prescriptive buffer. If excavation into the steep slope is avoided, the planned project will not adversely impact the slope's stability.

Erosion Hazard Area: The site also meets the City of Mercer Island's criteria for an Erosion Hazard Area. This has also been indicated on the attached Site Exploration Plan.

Proper erosion control implementation will be important to prevent adverse impacts to the site and neighboring properties, particularly if grading and construction occurs during the wet season. 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. Silty water cannot be discharged off the site, so a temporary holding tank should be planned for wet weather earthwork. A wire-backed silt fence bedded in compost, not native soil, or sand, should be erected as close as possible to the planned work area, and the existing vegetation west of the silt fence be in place. Rocked construction access and staging areas should be established wherever trucks will have to drive off of pavement, in order reduce the amount of soil or mud carried off the property by trucks and equipment. Covering the base of the excavation with a layer of clean gravel or rock is also prudent to reduce the amount of mud and silty water generated. Cut slopes and soil stockpiles should be covered with plastic during wet weather. Soil stockpiles should be minimized. Silty water accumulating in the excavation must not be allowed to flow off the site, or into Lake Washington. In wet conditions, this can require the use of temporary holding tanks (aka Baker tanks). 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: The attached Site Exploration Plan (Plate 2) denotes the extents of the critical areas that cover the site. Under MICC 19.07.160(C), the code-prescriptive buffer of 25 feet is required 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. An approximate prescriptive Steep Slope buffer from the toe of the northwestern steep slope is shown on the attached Site Plan and is shown as the prescriptive buffer from a shallow landslide hazard, which can be interpreted to exist within the man-made, northern steep slope area. This buffer is for reference only and is not drawn to scale. If development is proposed near the toe of the steep slope, additional mitigation measures may need to be implemented to facilitate the proposed construction without adversely affecting the slope.

No buffer is required by the MICC for an Erosion Hazard Area.

We recognize that the planned development will occur within the designated critical areas and their applicable prescriptive buffers. The recommendations presented in this geotechnical report are intended to allow the project to be constructed in the proposed configuration without adverse impacts to critical areas on the site or the neighboring properties. The geotechnical recommendations associated with 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:

> *Provided the recommendations in this report are followed, it is our professional opinion that the recommendations presented in this report for the planned alteration will render the development as safe as if it were not located in a geologically hazardous area and will not adversely impact critical areas on 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 conducted for this study encountered loose fill, and unconsolidated native soils to depths of 7.5 to 15 feet beneath the ground surface. On the upslope side of the proposed residence, very stiff, native silt was encountered beneath a depth of 15 feet, and continued to the base of the test boring, becoming harder with depth. On the downslope side of the proposed residence, dense sand and slightly silty sand were revealed beneath depths of 7.5 to 10 feet and continued to the maximum explored depths. These dense sands and hard silts are glacially compressed and are not susceptible to deep-seated instability.

The residence design and layout are preliminary at this time, and final siting locations, as well as slab and foundation elevations have not been defined at this time. Considering the preliminary nature of the design, the depth to suitable bearing soil encountered in our test borings, and anticipated depth of excavation, it would be most practical to plan to support the residence on a deep foundation system. For this development, driven, small-diameter pipe piles would likely be the most practical option, and are commonly used for similar residential projects. These small-diameter pipe piles would be driven through the upper loose and medium-dense soils, to refusal in the underlying very dense soils. Additional recommendations can be found in the ***Pipe Piles*** section of this report. The use of pipe piles instead of a conventional foundation system will limit the amount of excavation that would be needed to expose suitable bearing materials, which would help to reduce the total export quantities of soil during construction and reduce temporary shoring heights. The use of pipe piles instead of a conventional foundation system would also prevent post-construction settlement from occurring, which would occur if the foundations were constructed atop the looser native soils near the foundation level of the existing residence. Settlement sensitive, on-grade structures such as patios, slabs, walkways, or decks, should also be supported on piles to limit post-construction settlement.

As previously discussed, the new residence will contain a basement. We anticipate that excavations on the order of 10 feet could be needed to reach the foundation elevations in areas. Where shorter excavations area proposed, a temporary excavation inclination of no steeper than a 1:1 (Horizontal:Vertical) is appropriate given the soil conditions. No unsupported cuts should be made in front of the existing rockery along the northern side of the driveway, and care should be taken during excavations in front of the existing rockery located near the northeastern corner of the house, if it is to remain in place. We do not recommend that unshored excavations extend beneath a 2:1 (H:V) extending downward from any adjacent foundation, and do not recommend that vertical excavations be made on, or near the shared property lines. If the above-mentioned excavation inclination cannot be maintained within the property, and temporary excavation easements are not able to be obtained, temporary shoring will be needed. If the proposed design allows, the existing basement walls could be reused as temporary shoring walls to reduce the amount of additional temporary shoring. This may require that the existing walls be braced and would require that the new residence be constructed inside the existing basement walls. A structural engineer should be retained early in the design to determine if the existing basement walls can be adequately braced during construction. Where new, deep cuts are proposed, a rigid shoring system consisting of drilled soldier piles will be needed. Less rigid shoring systems, such as ecology blocks and steel plates, are not appropriate for the upper loose soil conditions. Recommendations for temporary shoring can be found in the ***Soldier Pile Shoring*** section of this report.

As previously discussed, the subject site is located within a potential landslide hazard area that encompasses much of the general vicinity. The core of the subject site consists of dense native soil that has a low potential for deep-seated landslides. However, any slope in the Puget Sound area has some potential for shallow soil movement in the near-surface soils, particularly after extended periods of concentrated precipitation. The oversteepened slope along the north side of the driveway may experience instability in the future, due to excessive groundwater or an earthquake. As discussed above in the ***Critical Area Study*** section, the recommendations presented in this report are intended to prevent adverse impacts to the stability of the site and prevent the development from adversely affecting the stability of surrounding properties. The proposed pile foundations and shoring walls will provide stability for the development area. The future property owners should be made well aware that there always exists at least some risk with owning property near steep slopes.

The site is underlain by low permeability soil. In addition to extensive drainage and waterproofing for the basement walls, we recommend installing an underslab drainage system beneath the basement slab of the new residence. This system would consist of a layer of clean crushed rock beneath the interior slab or crawlspace. The rock layer should be at least 9 to 12 inches thick and contain 4-inch diameter, perforated PVC pipes at no more than 15-foot center-to-center spacings. The entire rock layer and pipe system should be covered with a thick vapor retarder/barrier. The perforated pipes should tie into the exterior footing drains. The ***Drainage Considerations*** section of this report contains an expanded discussion of our subsurface drainage recommendations.

There is always some risk associated with shoring, excavation, and foundation construction near neighboring developed properties. It is imperative that unshored excavations do not extend below a 2:1 (Horizontal:Vertical) imaginary bearing zone sloping downward from existing footings. Contractors working on the construction of your home must be cautioned to avoid strong ground vibrations, which could cause additional settlement in the neighboring foundations. Installation of driven pipe piles is a loud process but does not result in strong ground vibrations. During demolition, strong pounding on the ground with the excavator, which is often used to break up debris and concrete, should not occur. Large equipment and vibratory compactors, such as hoepacks, should not be used close to the property lines. Additionally, in order to protect yourselves from unsubstantiated damage claims from the adjacent owners, 1) the existing condition of their foundations, pavements, and on-grade elements should be documented before starting site work, and 2) the footings and other settlement-sensitive elements, such as the western driveway, should be monitored for vertical movement during the shoring, excavation, and construction process. These are common recommendations for projects located close to existing structures that may bear on loose soil and have already experienced excessive settlement. We can provide additional recommendations for documentation and monitoring of the adjacent structures, if desired.

The soil that will be excavated for the new residence will consist of variable fill soil, fine-grained silt, and silty sand. These soils have a high fines content and were observed to be in an elevated moisture state during drilling. These qualities make the soil poorly drained, and exceedingly difficult to adequately compact for use as structural fill, even under optimum site conditions. Considering this, we do not recommend that the onsite soils be reused as structural fill. Free-draining, granular fill or gravel should be used behind backfilled walls where needed.

Due to the silty, fine-grained nature of the upper fill and native soils onsite, the steep inclination of the sloped site, and the Potential Landslide Hazard designation, it is our professional opinion that onsite infiltration or dispersion of stormwater is not feasible for this project. Pervious pavements should not be used for this project as they would only act to add a drainage surcharge to the subsurface drainage system of the house and could adversely affect the finished basement spaces.

The drainage and 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 buildup 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 1.41g and 0.49g, 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 0.66g. The dense soils that will support the foundations are not susceptible to seismic liquefaction under the ground motions of the MCE because of their dense nature.

PIPE PILES

Three- or 4-inch-diameter pipe piles driven with an 850- or 1,100- or 2,000-pound hydraulic jackhammer to the following final penetration rates may be assigned the following compressive capacities.

INSIDE PILE DIAMETER	FINAL DRIVING RATE (850-pound hammer)	FINAL DRIVING RATE (1,100-pound hammer)	FINAL DRIVING RATE (2,000-pound hammer)	ALLOWABLE COMPRESSIVE CAPACITY
3 inches	10 sec/inch	6 sec/inch	2 sec/inch	6 tons
4 inches	16 sec/inch	10 sec/inch	4 sec/inch	10 tons

> **Note:** The refusal criteria indicated in the above table are valid only for pipe piles that are installed using a hydraulic impact hammer carried on leads that allow the hammer to sit on the top of the pile during driving. If the piles are installed by alternative methods, such as a vibratory hammer or a hammer that is hard mounted to the installation machine, numerous load tests to 200 percent of the design capacity would be necessary to substantiate the allowable pile load. The appropriate number of load tests would need to be determined at the time the contractor and installation method are chosen.

As a minimum, Schedule 40 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.

We expect that the City of Mercer Island will require geotechnical observation of the pile installation. Considering this, the recommendations we have made above for minimum refusal criteria, and our previous experience with pile projects in close proximity to the site, it is our professional opinion that the recommended capacities do not need to be verified by load testing.

Pile caps and grade beams should be used to transmit loads to the piles. Isolated pile caps should include a minimum of two piles to reduce the potential for eccentric loads being applied to the piles. Subsequent sections of pipe can be connected with slip or threaded couplers, or they can be welded together. If slip couplers are used, they should fit snugly into the pipe sections. This may require that shims be used or that beads of welding flux be applied to the outside of the coupler.

Lateral loads due to wind or seismic forces may be resisted by passive earth pressure acting on the vertical, embedded portions of the foundation. For this condition, the foundation must be either poured directly against relatively level, undisturbed soil or be surrounded by level compacted fill. We recommend using an ultimate (no safety factor included) passive earth pressure of 300 pounds per cubic foot (pcf) for this resistance. If the ground in front of a foundation is loose or sloping, the passive earth pressure given above will not be appropriate. If additional lateral resistance for the foundation is needed, inclined helical anchors could be included in the foundation system. We could provide recommendations for such anchors, if they are needed.

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 level backfill:

PARAMETER	VALUE
Active Earth Pressure *	40 pcf
Passive Earth Pressure	300 pcf
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. 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 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.

Wall Pressures Due to Seismic Forces

Per IBC Section 1803.5.12, a seismic surcharge load need only be considered in the design of walls over 6 feet in height. A seismic surcharge load would be imposed by adding a uniform lateral pressure to the above-recommended active pressure. The recommended seismic surcharge pressure for this project is 9**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.

Retaining Wall Backfill and Waterproofing

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 onsite soils are not acceptable for wall backfill, due to their poor drainage characteristics and low compacted strength. 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.

BUILDING FLOORS

If no settlement can be tolerated in the building floors, the building floors should be constructed as structural slabs or framed floors that are designed to span between the pile supported foundation without any reliance on soil bearing. 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. As recommended in the ***General*** section, underslab drainage should be provided for the basement spaces, even if they step down through the house. A typical underslab drainage detail is included as Plate 8.

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.

SOLDIER PILE SHORING

Cantilevered soldier pile shoring systems have proven to be an efficient method for providing excavation shoring where excavation depths do not exceed 15 feet. Soldier pile walls would be constructed after making planned cut slopes, and prior to commencing the mass excavation, by setting steel H-beams in a drilled hole and grouting the space between the beam and the soil with concrete for the entire height of the drilled hole. The contractor should be prepared to case the holes or use the slurry method if caving soil is encountered. Excessive ground loss in the drilled holes must be avoided to reduce the potential for settlement on adjacent properties. If water is present in a hole at the time the soldier pile is poured, concrete must be tremied to the bottom of the hole.

As excavation proceeds downward, the space between the piles should be lagged with timber, and any voids behind the timbers should be filled with pea gravel, or a slurry comprised of sand and fly ash. Treated lagging is usually required for permanent walls, while untreated lagging can often be utilized for temporary shoring walls. Temporary vertical cuts will be necessary between the soldier piles for the lagging placement. The prompt and careful installation of lagging is important, particularly in loose or caving soil, to maintain the integrity of the excavation and provide safer working conditions. Additionally, care must be taken by the excavator to remove no more soil between the soldier piles than is necessary to install the lagging. Caving or overexcavation during lagging placement could result in loss of ground on neighboring properties. Timber lagging should be designed for an applied lateral pressure of 30 percent of the design wall pressure if the pile spacing is less than three pile diameters. For larger pile spacings, the lagging should be designed for 50 percent of the design load.

Soldier Pile Wall Design

Temporary soldier pile shoring that is cantilevered and that has a level backslope, should be designed for an active soil pressure equal to that pressure exerted by an equivalent fluid with a unit weight of 40 pounds per cubic foot (pcf). Traffic surcharges can typically be accounted for by increasing the effective height of the shoring wall by 2 feet. Slopes and buildings above the shoring walls will exert additional surcharge pressures. These surcharge pressures will vary, depending on the configuration of the cut slope and shoring wall. We can provide recommendations regarding slope and building surcharge pressures when the preliminary shoring design is completed.

It is important that the shoring design provides sufficient working room to drill and install the soldier piles, without needing to make unsafe, excessively steep temporary cuts. Cut slopes should be planned to intersect the backside of the drilled holes, not the back of the lagging.

Lateral movement of the soldier piles below the excavation level will be resisted by an ultimate passive soil pressure equal to that pressure exerted by a fluid with a density of 350 pcf. For permanent walls, we recommend a minimum factor of safety of 1.5 be applied to overturning and sliding calculations when using this ultimate value (temporary installations may use a factor of safety of 1.2). This soil pressure is valid only for a level excavation in front of the soldier pile; it acts on two times the grouted pile diameter. Cut slopes made in front of shoring walls significantly decrease the passive resistance. This includes temporary cuts necessary to install internal braces or rakers. The minimum embedment below the floor of the excavation for cantilever soldier piles should be equal to the height of the "stick-up."

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. While it may be more costly, constructing the foundation walls with a zone of free-draining in front of the shoring wall provides better long-term drainage protection. A typical detail for drainage of walls poured directly against shoring is attached to this report as Plate 6.

Footing drains 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. Drains should also be placed at the base of all earth-retaining walls. These drains should be surrounded by at least 6 inches of 1-inch-minus, washed rock that is encircled with 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 bottom of a slab floor or the level of a crawl space. The discharge pipe for subsurface drains should be sloped for flow to the outlet point. Roof and surface water drains must not discharge into the foundation drain system. A typical footing drain detail is attached to this report as Plate 7. For the best long-term performance, perforated PVC pipe is recommended for all subsurface drains. Clean-outs should be provided for potential future flushing or cleaning of footing drains.

If the structure includes an elevator, it may be necessary to provide special drainage or waterproofing measures for the elevator pit. If no seepage into the elevator pit is acceptable, it will be necessary to provide a footing drain and free-draining wall backfill, and the walls should be waterproofed. If the footing drain will be too low to connect to the storm drainage system, then it will likely be necessary to install a pumped sump to discharge the collected water. Alternatively, the elevator pit could be designed to be entirely waterproof; this would include designing the pit structure to resist hydrostatic uplift pressures.

Recommendations for underslab drainage can be found in the ***General*** section.

As a minimum, a vapor retarder, as defined in the ***Building Floors*** 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.

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 the residence 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 fills 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 on-site soils are not suitable for reuse as structural fill, due to its fine-grained, silty nature.

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).

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 test borings 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. 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.

The recommendations presented in this report are directed toward the protection of only the proposed residence from damage due to slope movement. 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. The owner of any property containing or located close to steep slopes must ultimately accept the possibility that some slope movement could occur, resulting in possible loss of ground or damage to the facilities around the proposed residence.

This report has been prepared for the exclusive use of Sharon Nguyen and her 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.

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 - 5	Test Boring Logs
Plate 6	Typical Shoring Drain Detail
Plate 7	Typical Footing Drain Detail
Plate 8	Typical Underslab Drainage 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.

MARC R. McGINNIS
27845

06/07/2021
Marc R. McGinnis, P.E.
Principal

MKM/MRM:kg

NORTH

(Source: King County iMap)

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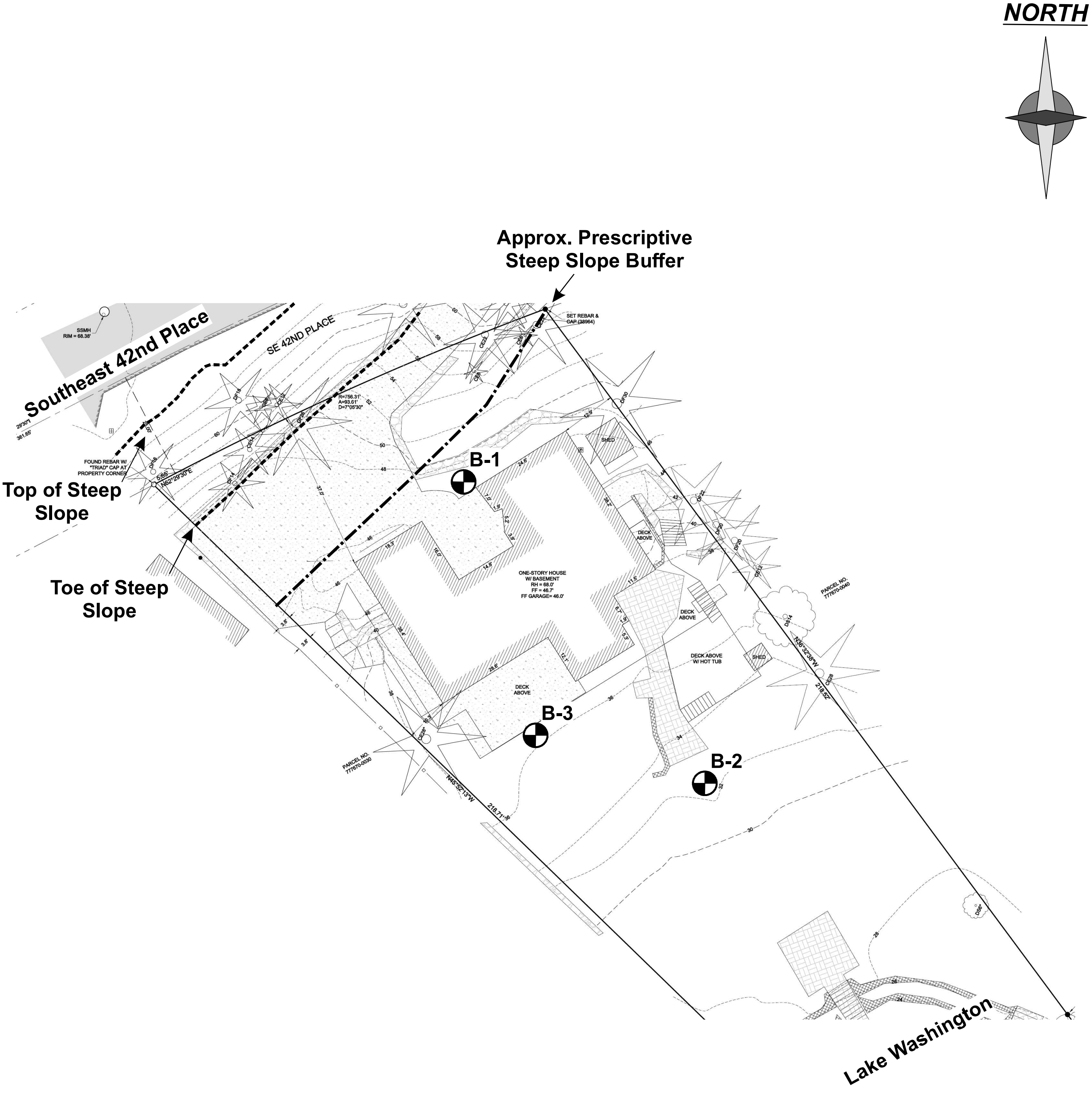
VICINITY MAP

9831 Southeast 42nd Place
Mercer Island, Washington

Job No:	Date:		Plate:
21165	May 2021		1



Legend:

● Test Boring Location

* The City of Mercer Island GIS tool maps the subject site as a Seismic Hazard Area, Potential Landslide Hazard Area, and an Erosion Hazard Area in its entirety. The prescriptive buffers for shallow Potential Landslide Hazard Areas under MICC 19.07 extend beyond the property boundaries.

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SITE EXPLORATION PLAN

9831 Southeast 42nd Place
Mercer Island, Washington

Job No:	Date:		Plate:
21165	May 2021	No Scale	2

BORING 1

	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
						Gravel over;
			12	1	FILL	Brown silty SAND intermixed with small pieces of gray silty sand, fine-grained, moist, medium-dense **(FILL)**
5			17	2		-becomes jumbled with pockets of sand and silt
			19	3	ML	Gray-brown slightly gravelly SILT, non-plastic, moist, medium-dense
10			10	4		-becomes mottled orange with roots
			22	5	SP SM	Gray-brown slightly silty SAND with thin silt lenses, fine-grained, moist, medium-dense
15			26	6		Bluish-gray SILT with thin, light gray streaks, low plasticity, moist, very stiff
20			23	7		-with trace gravel, becomes bedded
25			30	8	ML	-becomes slightly clayey in part, massive, hard
30			32	9		
35			54	10		
40						

*** Test boring was terminated at 36.5 feet on May 21, 2021.**
*** No groundwater seepage was encountered during drilling.**

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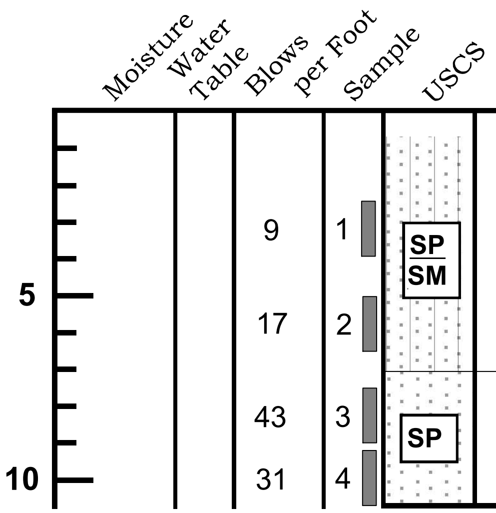
BORING LOG

9831 Southeast 42nd Place
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
21165	May 2021	MKM	3

BORING 2



Description

Grass over;

Gray, slightly gravelly, silty SAND with clean sand seams. fine-grained, moist, loose

-becomes gray-brown mottled orange, gravelly, slightly silty to silty, medium-dense

Gray-brown with rusting, gravelly SAND, fine-grained, moist, dense

*** Test boring was terminated at 10.5 feet on May 21, 2021 due to auger refusal.**
*** No groundwater seepage was encountered during drilling.**

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BORING LOG

9831 Southeast 42nd Place
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
21165	May 2021	MKM	4

BORING 3

	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
						Grass over;
			8	1	SP	Gray and brown mottled orange and rust, slightly gravelly SAND, fine to medium-grained, moist, loose
5			10	2	SP SM	Gray heavily mottled, silty SAND, fine-grained, moist, medium-dense
			18	3		Gravel -becomes slightly silty to silty with trace roots
10			38	4	SP	Gray-brown SAND with a thin lense of gray silt, fine-grained, very moist, dense
		▼	24	5		-becomes rusted with thin silty layers, wet, medium-dense
15			43	6	SP SM	Gray slightly silty to silty SAND with thin silt seams, fine-grained, wet, dense

*** Test boring was terminated at 16.5 feet on May 21, 2021 due to refusal.**

*** Groundwater seepage was encountered at 12.5 feet during drilling.**

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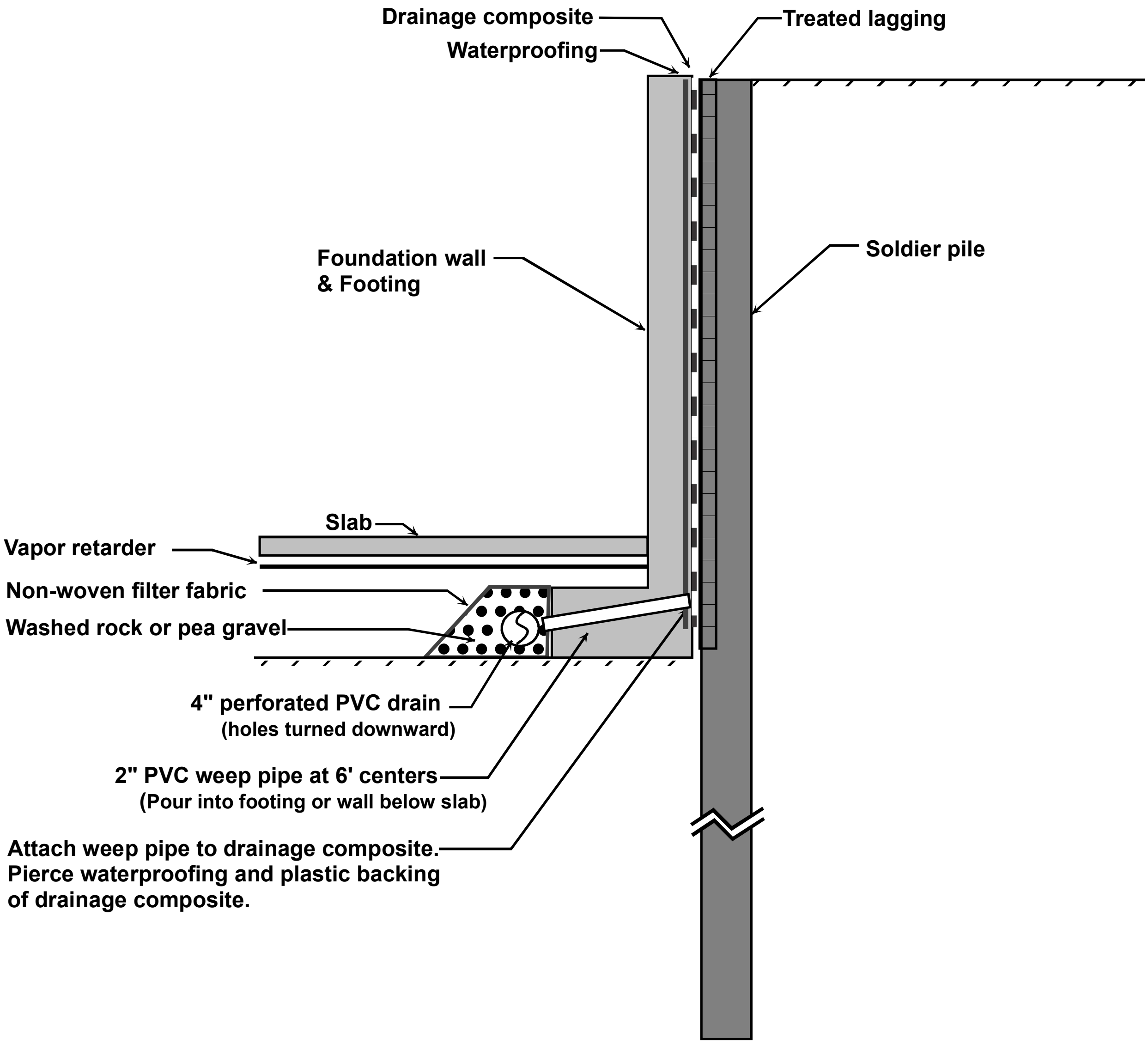
BORING LOG

9831 Southeast 42nd Place
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
21165	May 2021	MKM	5



Note - Refer to the report for additional considerations related to drainage and waterproofing.

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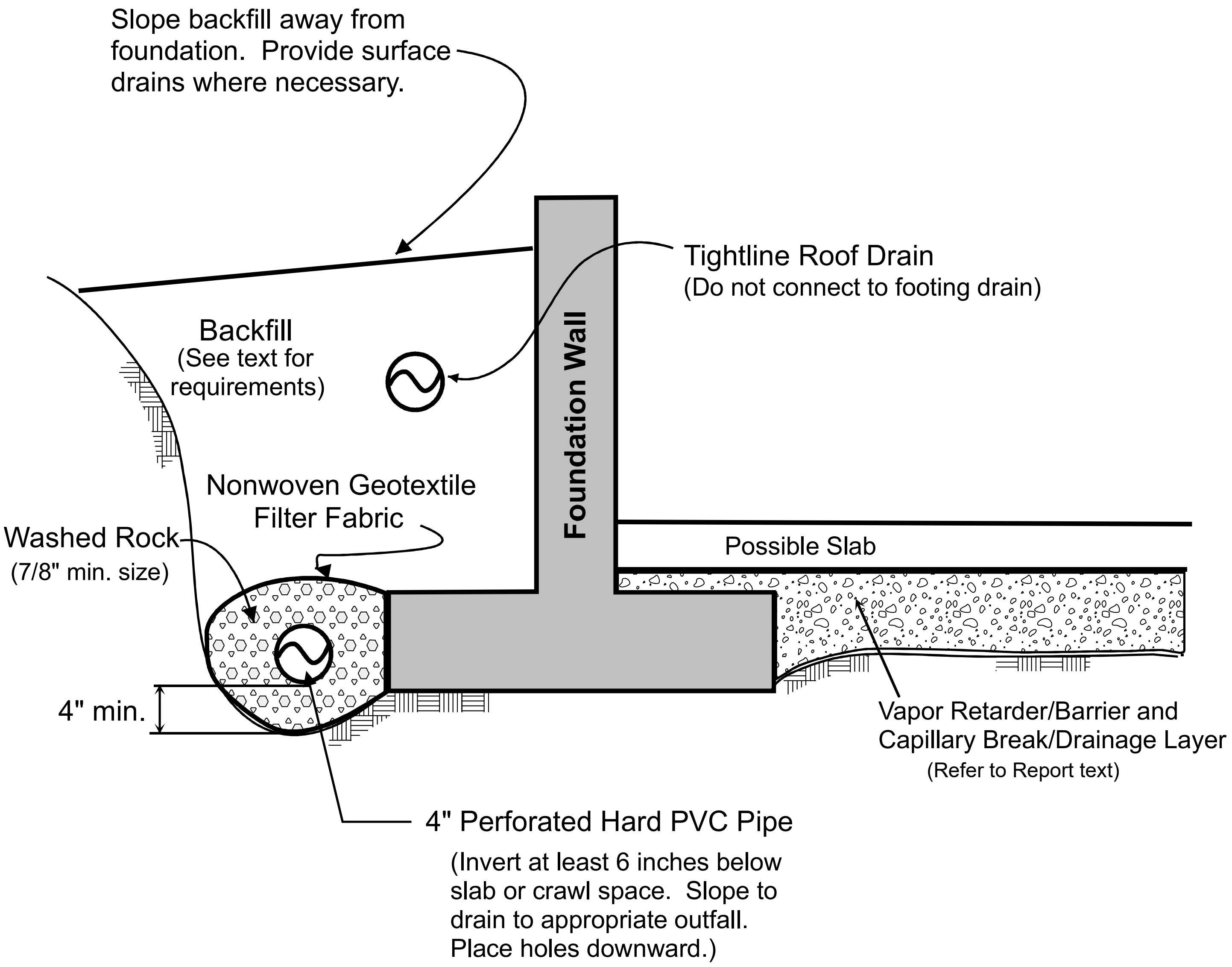
SHORING DRAIN DETAIL

9831 Southeast 42nd Place
Mercer Island, Washington

Job No:	Date:		Plate:
21165	May 2021		6



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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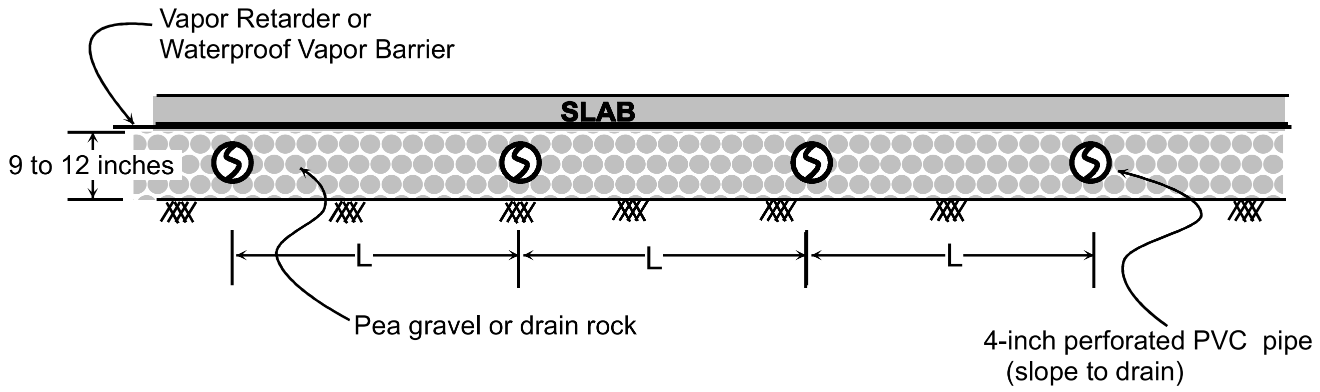
FOOTING DRAIN DETAIL

9831 Southeast 42nd Place
Mercer Island, Washington

Job No: 21165	**Date:** May 2021		**Plate:** 7



NOTES:

(1) Refer to the report text for additional drainage and waterproofing considerations.
(2) The typical maximum underslab drain separation (L) is 15 to 20 feet.
(3) No filter fabric is necessary beneath the pipes as long as a minimum thickness of 4 inches of rock is maintained beneath the pipes.
(4) The underslab drains and foundation drains should discharge to a suitable outfall.

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TYPICAL UNDERSLAB DRAINAGE

9831 Southeast 42nd Place
Mercer Island, Washington

Job No:	Date:		Plate:
21165	May 2021		8