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November 12, 2015

JN 14348

James Rudolf
5222 West Mercer Way
Mercer Island, Washington 98040

via email: james@glacierpeakcapical.com

Subject: **Transmittal Letter – Geotechnical Engineering Study**
Proposed Single-Family Residence
82xx West Mercer Way
Mercer Island, Washington

Dear Mr. Rudolf:

We are pleased to present this geotechnical engineering report for the single-family residence to be constructed in Mercer Island, Washington. 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 criteria for foundations, retaining walls, and temporary shoring. This work was authorized by your acceptance of our proposal, P-8976, dated July 21, 2014.

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.

D. Robert Ward, P.E.
Principal

TRC/DRW: at

GEOTECHNICAL ENGINEERING STUDY
Proposed Residence Building Pad and New Driveway
82xx West Mercer Way
Mercer Island, Washington

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

We have been provided with a topographic survey of the project site by Lanktree Land Surveying dated October 14, 2015. We were also provided with a Preliminary Driveway Plan that was prepared by CG Engineering and a Boundary Line Adjustment (BLA) drawing prepared by R.W. Thorpe dated February 18, 2015.

The project site consists of two adjacent properties that area located on the western (project west) side of West Mercer Way. There is an existing driveway on the southern property that is located at and near the adjoining property line of these properties. The driveway plan indicates this driveway will be widened as part of this project, and a new "hammerhead" will extend off the north side of the driveway and onto the northern property about 200 feet west of the eastern property line. Up to approximately 8 feet of fill soil is needed to raise the existing ground on the western side of the hammerhead. A new storm drain system is illustrated on the driveway plan.

The BLA indicates that a new residence will be located on the northern property within an area about 40 to 125 feet west of the eastern property line. We expect that the residence will have a basement level that will daylight toward the west, and that cuts in the range of about 10 feet will be required for the basement excavation on the eastern portion of the residence.

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 property in the southwestern portion of Mercer Island. As noted earlier, this project is located on two adjacent properties that are west of West Mercer Way. Approximately the eastern 225 feet of the northern property and the 150 feet of the southern property are mostly undeveloped, with the exception of driveways that provide access to houses further west. The northern driveway "snakes" through the northern property, while the southern driveway is generally straight.

The ground surface on the site within about 250 feet of from the street slopes toward the west at an average inclination of about 30 percent. However, the edge of this slope just below the street edge is quite steep (greater than 40 percent) and about 12 feet tall. Another 12-foot-tall area that is at or just steeper than 40 percent is on the middle-northern edge of the northern property; both of these 12-foot tall areas are considered Steep Slopes per Mercer Island Code (MICC). Most of the remainder of the slope declines to the west at an inclination of about 20 to 25 percent, although there is a portion near the middle of the northern property, about 150 feet west of the eastern property line, that western edge of the proposed residence) that slopes at just approximately 40 percent over a height of about 10 feet. The undeveloped portion of the properties is mostly vegetated with mature deciduous trees, brush, and blackberry vines. We did not observe indications of slope instability at the properties where the new residence and driveway are proposed, and are not aware of landslides within the site in the past one hundred years.

SUBSURFACE

The subsurface conditions were explored by excavating three test pits in roughly the proposed development areas on the site as shown on the Site Exploration Plan, Plate 2. Our exploration program was based on the proposed construction, anticipated subsurface conditions based on published geology maps and those encountered during exploration, and the scope of work outlined in our proposal.

The test pits were excavated on September 5, 2014 with a rubber-tired backhoe. A geotechnical engineer from our staff observed the excavation process, logged the test pits, and obtained representative samples of the soil encountered. "Grab" samples of selected subsurface soil were collected from the backhoe bucket. The Test Pit Logs are attached to this report as Plates 3 and 4.

Soil Conditions

Below about one foot of topsoil, Test Pits 1 and 3 encountered loose to medium-dense sand with gravel that extended to depths of 5 and 3 feet, respectively. Underlying this sand with gravel, and below the topsoil in Test Pit 2, we observed a landslide deposit (colluvium) that consisted of non-plastic, loose to medium-dense silt. The colluvium extended to a depth of 11.5 feet in Test Pit 3, and to the maximum excavated depth in Test Pits 1 and 2 of 14.5 feet. The colluvium in Test Pit 3 was underlain with dense native sand with gravel and silt. The sand with gravel and silt had a thickness of 1.5 feet and was underlain by dense silt that extended to the base of that exploration at a depth of 14 feet.

The Mercer Island Landslide Hazard Assessment map by Kathy Troost and Aaron Wischer dated April 2009 shows that the site has been designated as a Landslide Hazard Area. That map also shows that the site has a slope inclination of 15 percent or steeper, and that several landslides have been identified in the site vicinity. This map shows that the site is underlain by landslide and mass wastage deposits. The soil revealed in our test pits is very consistent with the assessment map, and relatively consistent with soils we have observed on nearby sites in the past.

Groundwater Conditions

No groundwater seepage was observed in the test pits, which were left open for only a short time period. However, it should be noted that groundwater levels vary seasonally with rainfall and other factors. It is possible that groundwater could be found within or near the base of the colluvium, as well as in the upper sandy soils, during the normally wet winter and spring months.

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. The relative densities and moisture descriptions indicated on the test pit logs are interpretive descriptions based on the conditions observed during excavation.

The compaction of test pit backfill was not in the scope of our services. Loose soil will therefore be found in the area of the test pits. If this presents a problem, the backfill will need to be removed and replaced with structural fill during construction.

SEISMIC/LIQUEFACTION 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 Site Class). The site soils have a low potential for seismic liquefaction because of their medium-dense condition and/or silty/clayey nature, and the lack of near-surface groundwater

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 pits conducted for this study encountered colluvium (landslide deposits) at the ground surface in the areas of proposed development. However, it is our professional opinion that the development of the site is suitable provided recommendations in this report are followed. The test pit excavated west of the likely building pad for the proposed residence (also in the general vicinity of the encountered dense sand at a depth of 11.5 feet, while the other two test pits did not extend out of the colluvium at 14.5 feet. However, based on our experience in the site vicinity, we anticipate that the colluvium likely is no deeper than 20 feet. If a more specific depth to the base of the colluvium is needed, test borings would need to be drilled. The colluvium has the potential to settle and possibly more laterally due to new building and soil loads. Therefore, it is our professional opinion that the new residence should be supported on a deep foundation system that transfers foundation loads to the underlying competent soils beneath the colluvium soils. The deep foundation system should consist of drilled, reinforced concrete piles. Further recommendations regarding design and construction of those foundations can be found in the ***Drilled Concrete Piles*** section of this report.

In addition to installing the drilled piles for the foundation of the new residence, another significant geotechnical engineering consideration for the project is the proposed fill needed at the driveway hammerhead. It appears that up to about 8 feet of fill will be needed. Typical fill soil adds a considerable amount of weight to existing soil. Because the upper soil in the area of the hammerhead was found to be about 11 feet of colluvium, there is a possibility of settlement or lateral movement of the colluvium if typical soil is used to fill the hammerhead area. To deter this settlement/movement, we recommend that one of the following recommendations below be followed. The most advantageous method should be determined when more specific plans and costs are fully considered: The two recommendations include:

1. Using geofoam material as fill instead of soil. Geogoam is essentially weightless, but provides excellent bearing and lateral stability for things like driveways. The geofoam is, however, expensive fill material. In addition, it would need to be protected from the possibility of oil contamination is asphalt is used for the driveway as oil products can degrade the Geofoam.

2. Installing a retaining wall beneath the ground that extends down to and/or below the dense soil that is beneath the colluvium. This could be separate from the future driveway wall needed to support new soil fill. Again, this wall would be expensive.

The remainder of the new driveway, as well as the hammerhead will be paved, and a new stormwater system is proposed for the driveway and hammerhead. Therefore, stormwater runoff from the new driveway will be well controlled and very likely be much better than the existing driveway's stormwater system. Stormwater from the new residence will also be controlled and not allowed to flow on/into the site soils.

Stormwater infiltration at the site is not feasible for several reasons, including; sloping conditions, the very low permeability characteristic of the near-surface silt soils, and because the near-surface soils are colluvium. In addition, the silt soils are extremely moisture sensitive and are not suitable for reuse as structural fill.

As with all properties in the Puget Sound Areas, erosion control measures are needed during the site development. These will protect the site and adjacent sites from the possibility of erosion. The amount and type of erosion control measures will depend heavily on the weather conditions that are encountered during construction. However, we believe the following will be needed:

1. Installing a silt fence will be needed around the downslope sides of any cleared areas.

2. Existing pavements, ground cover, and landscaping should be left in place wherever possible to minimize the amount of exposed soil.

3. Placing rocked staging areas and construction access roads should be provided to reduce the amount of soil or mud carried off the property by trucks and equipment. Wherever possible, the access roads should follow the alignment of planned pavements. Trucks should not be allowed to drive off of the rock-covered areas.

4. Covering cut slopes and soil stockpiles with plastic during times of wet weather and potential wet weather.

5. Placing mulch, loose straw, and/or hydroseed to bare areas following rough grading that will not be immediately covered with landscaping or an impervious surface.

6. Periodically maintaining or modifying the temporary erosion control measures to address specific site and weather conditions.

As noted earlier, the project is a Landslide Hazard Area. As noted above, it is our professional opinion that this development can be constructed provided the recommendations (such as those noted earlier in this section of the report) are followed. Per Mercer Island Code (MICC) 19.07.060(D), alterations of Geologic Hazard areas such as Landslide Hazard Areas may occur if the code official concludes that such alterations:

a. Will not adversely impact other critical areas;
b. Will not adversely impact (e.g., landslides, earth movement, increase surface water flows, etc.) the subject property or adjacent properties;
c. Will mitigate impacts to the geologic hazard area consistent with best available science to the maximum extent reasonably possible such that the site is determined to be safe; and
d. Include the landscaping of all disturbed areas outside of building footprints and installation of all impervious surfaces prior to final inspection.

In our professional opinion, all of these criteria will be met provided the recommendations are followed in this report are followed, as well as standard construction and erosion control maintenance are followed. In addition, because the site is considered a Geologic Hazard Area per MICC, a "statement of risk" is required. As such, our statement is as follows: In our opinion, provided the recommendations presented in this report are followed, the proposed development will not adversely impact other critical areas, the subject property, or adjacent properties. In addition, the development (if designed per our recommendations) will have been designed so that the risk to the lot and adjacent properties is mitigated such that the site is determined to be safe.

Per MICC 19.09.040, the applicant must determine the location of a building pad by considering vegetation, topography, critical areas, and the relationship of the proposed building pad to existing/proposed homes. The building pads shall not be located within yard setbacks, rights-of-way and Critical Areas or its buffers; however, building pads may be located within Landslide Hazard Areas provide the building pad is not located in Steep Slopes or within 10 feet from the top of a Steep Slope. As noted earlier, the site is a Landside Hazard Area. In addition there are also some other potential Critical, Geologic Hazard Areas at the site: Seismic Hazard Area and Erosion Hazard Area. <u>It is our opinion that the building pad area proposed on the site is suitable with regards to MICC 19.09.040.</u> A discussion of the Critical, Geologic Hazard Areas at the proposed building pad area and our opinions regarding their relevance to MICC 19.09.040 is as follows:

- Although the site is a Landside Hazard Area (LHA), there are only two small areas with the LHA that are also considered a Steep Slope. These slopes are on the eastern edge and northern-middle edge of the northern property. The current preliminary plan indicates that the building plan will be at least 10 feet from these Steep Slopes. It appears that there is sufficient space on the property to maintain a 10-foot separation if the building pad were to move slightly. Because of this, and because the new residence will be founded on drilled concrete piles, it is our opinion that the building pad should be suitable with regard to the LHA.

- A Seismic Hazard Area (SHA) are areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction or surface faulting. As noted earlier, the soil at the site is not prone to liquefaction. Surface faulting is not a possibility because bedrock material is not located near the ground surface at the site or in the area. The new residence will be constructed on drilled piles that are resistant to ground shaking or slope movement. For all these reasons, it is our professional opinion that the building pad (residence) is suitable from a geotechnical engineering standpoint with regards to code for an SHA.

- It is our professional opinion that sites only have an erosion potential during construction when vegetation is removed. We did not observe indications of current erosion at the site and we strongly believe that erosion will not be an issue once the residence is constructed, the driveway and hammerhead are installed, and other landscaping/hardscaping features are installed. As noted earlier in this section of the report, erosion control measures are needed during construction, and these measures will mitigate erosion issues. Therefore, this project is suitable with regards to erosion potential.

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 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.

DRILLED CONCRETE PILES

Based on our explorations, we anticipate that the holes could be drilled without casing, but 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 of adjacent structures. If water is present in a hole at the time concrete is poured, concrete must be tremied to the bottom of the hole.

A wide variety of depths and pile diameters are possible, but we recommend using a minimum pier diameter of 16 inches. The piles should extend through the colluvium soil and into the underlying undisturbed, competent, non-colluvial soil. For a minimum embedment of 10 feet into the competent native soils, and a pier diameter of 16 inches, we recommend assuming an allowable compressive capacity of 20 tons per pile. Center-to-center pier spacing should be no less than three times the pile diameter. Based on our explorations and our experience, the required pile length may be 20 to 30 feet, or greater, below the existing ground to reach adequate embedment. The pile lengths will be less where excavations for the residence basement are made.

We recommend reinforcing each pier its entire length. This typically consists of a cage of rebar extending a portion of the pier's length, with a full-length center bar. For design of the reinforcing, we recommend that the piers be assumed to have a point of fixity (point of maximum bending moment) at a depth of 10 feet below the top of the pile. The lateral capacity of a pier is a function of both the soil that surrounds the pier and the composition of the pier itself. Passive earth pressures on the grade beams will also provide some lateral resistance. If structural fill is placed against the outside of the grade beams, the design passive earth pressure from the fill can be assumed to be equal to that pressure exerted by an equivalent fluid with a density of 300 pcf. This passive resistance is an ultimate value that does not include safety factors.

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.**

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 passive pressure given is appropriate only for the depth of level, 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. We recommend a safety factor of at least 1.5 for overturning and sliding, when using the above values to design the walls. Restrained wall soil parameters should be utilized for a distance of 1.5 times the wall height from corners or bends in the walls. 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

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 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 silt soil should not be used as free-draining wall backfill. 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 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. 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 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 build up 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***, ***Slabs-On-Grade***, 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 building floors can be constructed as slabs-on-grade atop firm soils or on structural fill. The subgrade soil must be in a firm, non-yielding condition at the time of slab construction or underslab fill placement. 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 also notes that vapor *retarders* such as 6-mil plastic sheeting have been used in the past, but are now recommending a minimum 10-mil thickness for better durability and long term performance. 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.

In the recent past, ACI (Section 4.1.5) recommended that a minimum of 4 inches of well-graded compactable granular material, such as a 5/8-inch-minus crushed rock pavement base, be placed over the vapor retarder or barrier for their protection, and as a "blotter" to aid in the curing of the concrete slab. Sand was not recommended by ACI for this purpose. However, the use of material over the vapor retarder is controversial as noted in current ACI literature because of the potential that the protection/blotter material can become wet between the time of its placement and the installation of the slab. If the material is wet prior to slab placement, which is always possible in the Puget Sound area, it could cause vapor transmission to occur up through the slab in the future, essentially destroying the purpose of the vapor barrier/retarder. Therefore, if there is a potential that the protection/blotter material will become wet before the slab is installed, ACI now recommends that no protection/blotter material be used. However, ACI then recommends that, because there is a potential for slab curl due to the loss of the blotter material, joint spacing in the slab be reduced, a low shrinkage concrete mixture be used, and "other measures" (steel reinforcing, etc.) be used. ASTM E-1643-98 "Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs" generally agrees with the recent ACI literature.

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***, ***Permanent 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

Excavation slopes should not exceed the limits specified in local, state, and national government safety regulations. Temporary cuts to a depth of about 4 feet may be attempted vertically in unsaturated soil, if there are no indications of slope instability. However, vertical cuts should not be made near property boundaries, or existing utilities and structures. Based upon Washington Administrative Code (WAC) 296, Part N, the soil at 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 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 2.5:1 (H:V). Compacted fill slopes should not be constructed with an inclination steeper than 2.5:1. 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.

Any disturbance to the existing slope outside of the building limits may reduce the stability of the slope. Damage to the existing vegetation and ground should be minimized, and any disturbed areas should be revegetated as soon as possible. Soil from the excavation should not be placed on the slope, and this may require the off-site disposal of any surplus soil.

DRAINAGE CONSIDERATIONS

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. Footing drains 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. Plate 5 presents typical considerations for footing drains and Plate 6 presents a typical shoring drain detail. All roof and surface water drains must be kept separate from the foundation drain system.

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 even a few inches of free draining gravel underneath the vapor retarder limits the potential for seepage to build up on top of the vapor retarder.

No 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 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. Additionally, a drainage swale should be provided upslope of the building to intercept surface run-off and direct it into the storm drains. Water from roof, storm water, and foundation drains should not be discharged onto slopes; it should be tightlined to a suitable outfall located away from any slopes.

GENERAL EARTHWORK AND STRUCTURAL FILL

All building and pavement areas should be stripped of surface vegetation, topsoil, organic soil, and other deleterious material. It is important that existing foundations be removed before site development. 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, behind permanent retaining or foundation walls, 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 noted earlier, the onsite silt soil should not be used as structural fill due to its high silt and moisture content.

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. We recommend testing the fill as it is placed. If the fill is not sufficiently compacted, it can 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 relative compactions for structural 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 test pits 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 pits. 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 James Rudolf 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.

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 Pit Logs
Plate 5	Typical Footing Drain Detail
Plate 6	Typical Shoring 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,

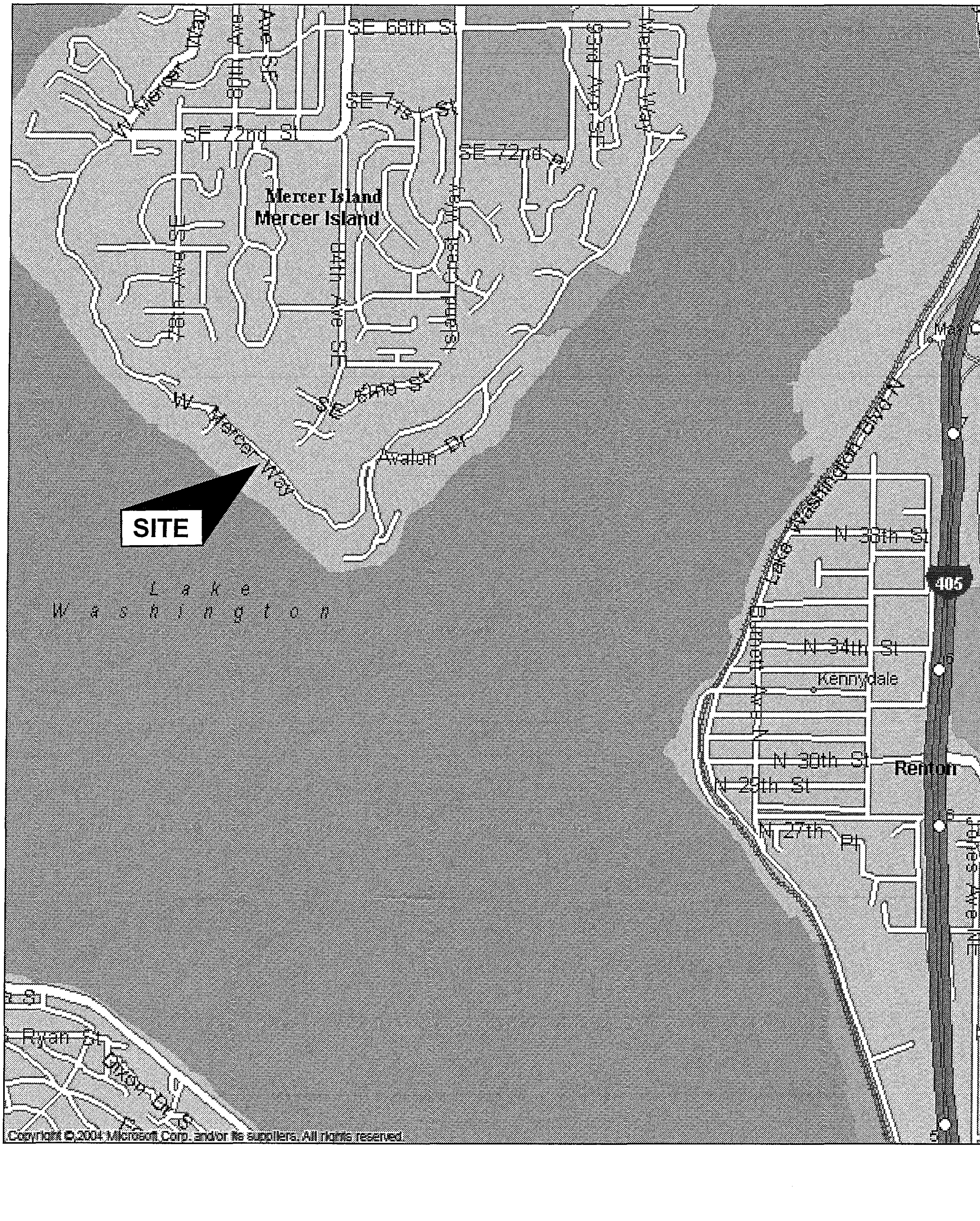
GEOTECH CONSULTANTS, INC.

11/12/15

D. Robert Ward, P.E.
Principal

TRC/DRW: at

NORTH



(Source: Microsoft MapPoint, 2013)

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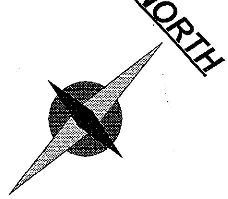
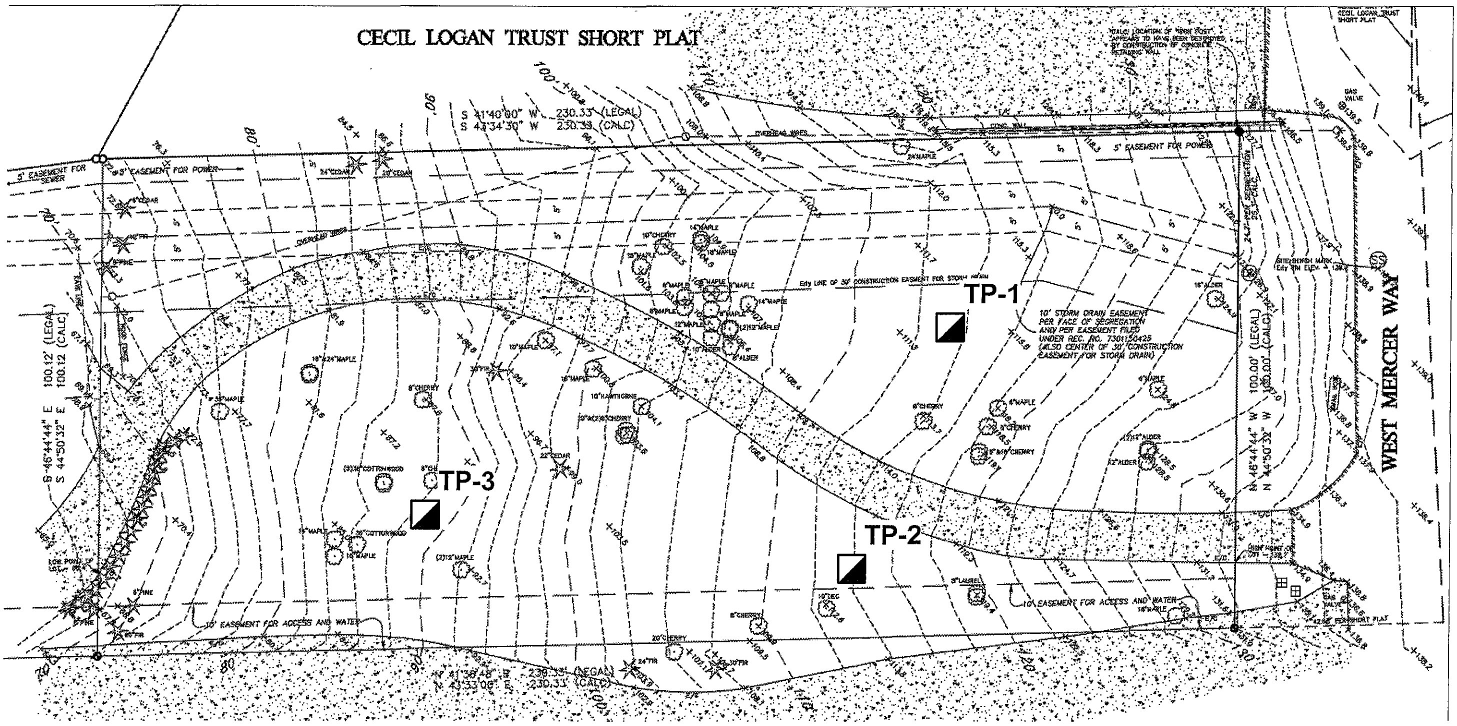
VICINITY MAP

8255 West Mercer Way
Mercer Island, Washington

Job No:	Date:		Plate:
14348	Sept. 2014		1





Legend:

◪ Test Pit Location

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SITE EXPLORATION PLAN

8255 West Mercer Way
Mercer Island, Washington

Job No:	Date:		Plate:
14348	Sept. 2014	No Scale	2

TEST PIT 1

Depth (ft.)	Moisture Content (%)	Water Table	USCS	Description
				TOPSOIL
			SW	Gray-brown SAND with gravel, fine to coarse-grained, moist, loose to medium-dense
5			ML	Gray-brown SILT, non-plastic, moist, loose to medium-dense
				-becomes fractured
10				-becomes gray and slightly plastic
15				

* **Test Pit terminated at 14.5 feet on September 5, 2014.**
* **No groundwater observed during excavation.**
* **No caving observed during excavation.**

TEST PIT 2

Depth (ft.)	Moisture Content (%)	Water Table	USCS	Description
				TOPSOIL
			ML	Light-brown SILT, non-plastic, moist, loose to medium-dense
5				-becomes gray-brown and fractured
10				
				-becomes gray
15				

* **Test Pit terminated at 14.5 feet on September 5, 2014.**
* **No groundwater observed during excavation.**
* **No caving observed during excavation.**

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TEST PIT LOG

8255 West Mercer Way
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
14348	Sept. 2014	TRC	3

TEST PIT 3

Depth (ft.)	Moisture Content (%)	Water Table	USCS	Description
				TOPSOIL
			SW	Brown SAND with gravel, fine to coarse-grained, moist, loose to medium-dense
			ML	Light-brown SILT, non-plastic, moist, medium-dense
5				-becomes gray-brown and fractured
				-layer of silty SAND, fine-grained, moist
10				
			SW	Gray-brown SAND with gravel and silt, fine to coarse-grained, moist, dense
			ML	Gray-brown SILT, non-plastic, moist, dense
15				

* **Test Pit terminated at 14.0 feet on September 5, 2014.**
* **No groundwater observed during excavation.**
* **No caving observed during excavation.**

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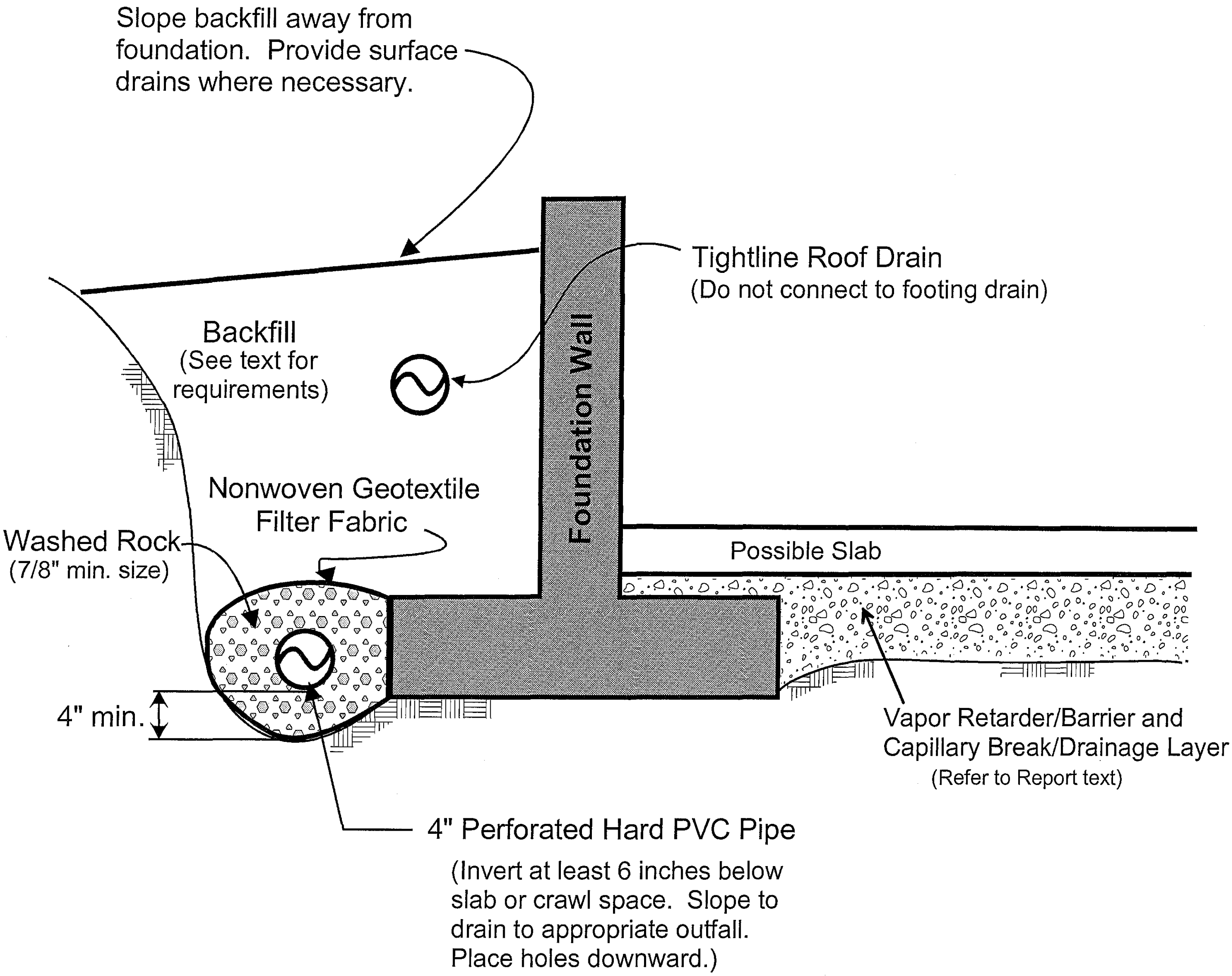
TEST PIT LOG

8255 West Mercer Way
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
14348	Sept. 2014	TRC	4



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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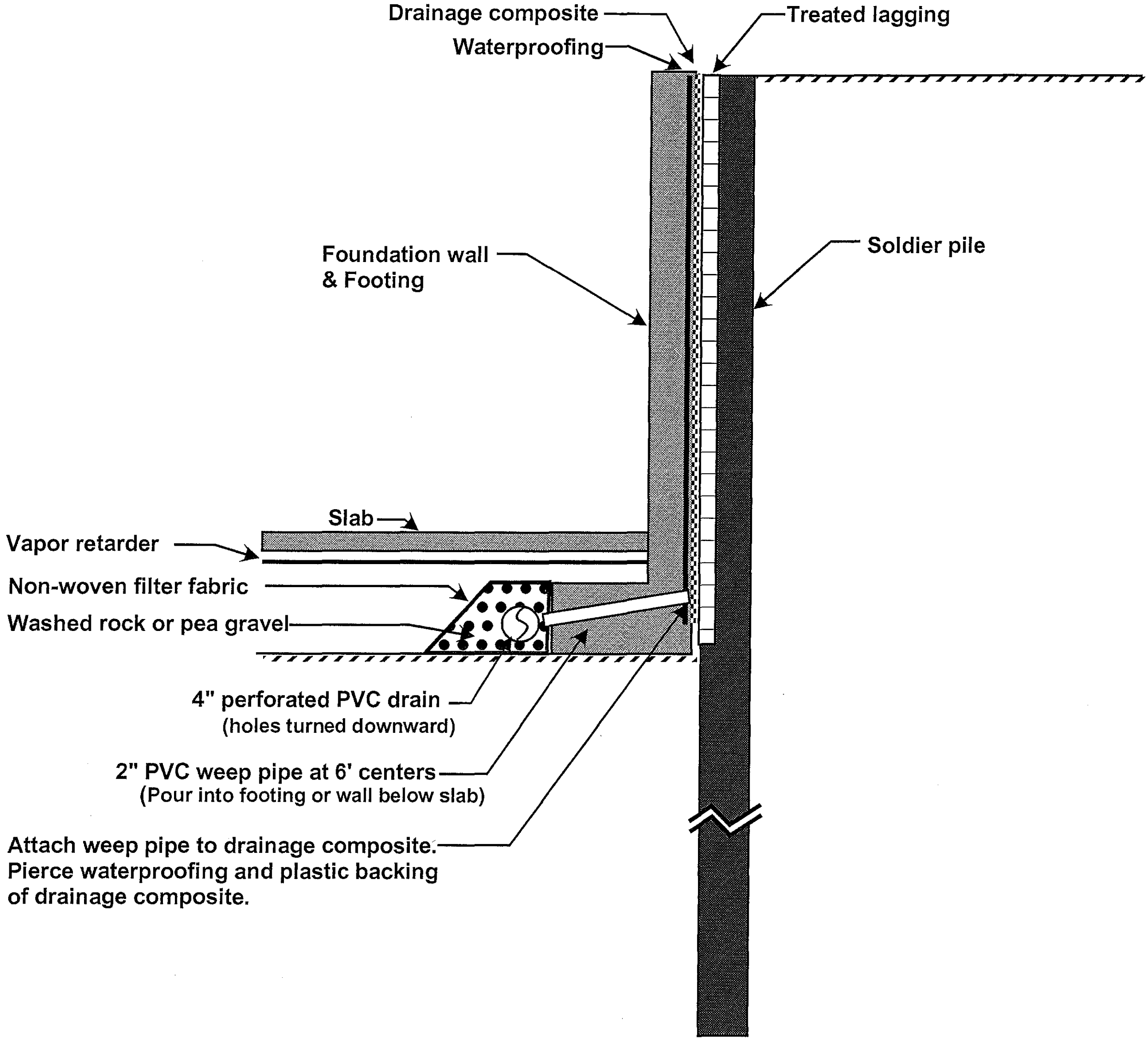
FOOTING DRAIN DETAIL

8255 West Mercer Way
Mercer Island, Washington

Job No:	Date:		Plate:
14348	Sept. 2014		5



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

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SHORING DRAIN DETAIL

8255 West Mercer Way
Mercer Island, Washington

Job No:	Date:		Plate:
14348	Sept. 2014		6