GEOTECH
CONSULTANTS, INC.

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September 21, 2017

JN 16543

The Ladybug Trust
1420 – 5th Avenue, Suite 4200
PO Box 91302
Seattle, Washington 98111-9402

Attention: Michael Morgan
via email: morganm@lanepowell.com

Subject: **Shoring Addendum**
Proposed Ogden Point Development
3675 West Mercer Way
Mercer Island, Washington

Dear Mr. Morgan:

We have prepared this letter to present the findings of recent supplemental test borings and to provide recommendations for a proposed shoring wall for the proposed development. We prepared a geotechnical study for a proposed residence dated January 3, 2017. This letter should be considered supplemental to that study, and is intended to address the tall permanent shoring for the north side of the driveway and detached residence.

The property is angled from True North. For the purposes of this report, we have designated Plan North as perpendicular to the shoreline of Lake Washington. This is depicted on the Site Exploration Plan, Plate 1.

We have been provided with a retaining wall plan prepared by Demetriou Architects dated September 7, 2017. Based on that plan we understand that a second residence will be constructed toward the east side of the site. We expect that this structure will have a basement that daylights toward the south and one or more upper levels. The driveway for the previously planned primary house will continue eastward to provide access this second, eastern residence. An excavation of up to 36 feet will be required for the eastern part of the driveway. A shoring wall will be needed to support the excavation. We understand that the tall wall along the driveway will have three tiers, with planters between the tiers. The shoring will continue eastward along the north side and northern part of the east side of the eastern residence. We expect that the shoring will be permanent, thereby minimizing internal leads for the planter walls and basement walls of the detached residence.

As part of our previous study, the closest boring to the new walls was Boring 8. We explored the subsurface conditions along some of the tallest section of the wall by drilling two test borings (Borings 9 and 10) at the approximate locations shown on the Site Exploration Plan, Plate 1. The borings were drilled on September 14, 2017 using a track-mounted, hollow-stem auger drill. Samples were taken at approximate 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 2 and 3.

Soil Conditions

The uppermost native soils encountered in the recent borings consisted silty sand that was loose to medium-dense close to the ground surface and was medium-dense at a depth of 5 feet. The silty sand material was underlain by massive silt that was medium-dense or dense, and included some plastic zones. These soils conditions were consistent with our previous findings. The recent borings could be drilled to a greater depth, verifying conditions below the expected excavation. No groundwater seepage was observed in the recent test borings. Borings 9 and 10 were drilled following a very dry summer. The previous borings did encounter zones of seepage above and within the silt. This condition has been encountered on other projects in the vicinity where cuts were made into the slopes.

CONCLUSIONS AND RECOMMENDATIONS

General

Cantilevered and/or tied-back soldier-pile shoring walls are needed to support the northern side of the driveway excavation, and the excavation for the proposed eastern residence. Taller shoring walls, approximately 15 feet or more, will likely need to be tied back. The shoring could be considered temporary, whereby retaining walls would be needed for long-term retaining of the excavations, or be permanent. If the solider pile walls are permanent, the planter and residence walls would not have to withstand large soil loads. This is particularly true if geofoam is needed for fill between the soldier pile walls and the planter or basement walls. The geofoam is lightweight and essentially supporting. Although our recent borings did not encounter groundwater seepage, it is very likely that some seepage will emerge from the face of the deep excavation. To keep that water from emerging through cracks or joints in the permanent wall, we recommend that waterproofing be installed behind permanent retaining walls. Considering the height of the walls, installing a wider drainage zone in front of the shoring would be most prudent, especially next to the detached residence. Geofoam combined with gravel backfill would provide a suitable drainage path for any subsurface water that may flow through the lagging of the soldier piles. This would provide a zone of 2 to 3 feet between the soldier piles and the permanent wall.

As with any slope in the northern part of the property, there is a potential for soil movement, especially near the ground surface. Such potential soil movement in the upper, northern part of the site would have a potential to adversely impact the proposed eastern residence. Therefore, we recommend that the northern wall of the structure be constructed as a catchment wall to resist the impact load of a landslide. Catchment walls are typical in the Puget Sound region. Additional recommendations are presented in the ***Landslide Catchment Wall*** section.

Soldier Pile Shoring

This section is for the consideration of cantilevered and tied-back soldier pile systems to be used as either temporary or permanent shoring for the project. These systems have proven to be a very suitable for providing excavation shoring for projects such as this. Tied-back walls are

typically more economical than cantilevered walls where the depth of excavation is greater than 15 feet.

Soldier Pile Installation

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 or restrained by one row of tiebacks, 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 35 pounds per cubic foot (pcf). Below the steep northern slope this pressure should increase to 55 pcf. To design temporary tied-back shoring with more than one row of tiebacks and a level backslope, we recommend assuming that the lateral active soil pressure on the wall, expressed in pounds per square foot (psf), is equal to 20**H**, where **H** is the total height of the excavation in feet. This should be increased to 37**H** below the steep northern slope.

For permanent shoring, the equivalent active pressures given above should be increased by 5 pcf, and the lateral active pressures for more than one row of tiebacks increased by 3**H** psf.

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. 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. The ultimate passive resistance does not include a safety factor. 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." Tied-back soldier piles should be embedded no less than 10 feet below the lowest point of the excavation, including footing and utility excavations.

The vertical capacity of soldier piles to carry the downward component of the tieback forces will be developed by frictional shaft resistance along the embedded length.

PARAMETER	DESIGN
Pile Shaft Friction	750 psf

Where: psf is Pounds per Square Foot.

The above values assume that the excavation is level in front of the soldier pile and that the bottom of the pile is embedded a minimum of 10 feet below the floor of the excavation. The concrete surrounding the embedded portion of the pile must have sufficient bond and strength to transfer the vertical load from the steel section through the concrete into the soil.

Drilled and Grouted Tieback Anchors

General considerations for the design of tied-back soldier-pile walls are presented on Plate 4. We recommend installing tieback anchors at inclinations between 20 and 30 degrees below horizontal. The tieback will derive its capacity from the soil-grout strength developed in the soil behind the no-load zone. The minimum grouted anchor length should be 10 feet. The no-load zone is the area behind which the entire length of each tieback anchor should be located. To prevent excessive loss-of-ground in a drilled hole, the no-load section of the drilled tieback hole should be backfilled with a sand and fly ash slurry, after protecting the anchor with a bond breaker, such as plastic casing, to prevent loads from being transferred to the soil in the no-load zone. The no-load section could be filled with grout after anchor testing is completed.

During the design process, the possible presence of foundations or utilities close to the shoring wall must be evaluated to determine if they will affect the configuration and length of the tiebacks.

Based on the results of our analyses and our experience at other construction sites, we suggest using an adhesion value of 900 psf to design temporary anchors, if the mid-point of the grouted portion of the anchor is more than 10 feet below the overlying ground surface. An allowable adhesion value of 750 psf should be used for permanent anchors. This value applies to non-pressure-grouted anchors. Pressure-grouted or post-grouted anchors can often develop adhesion values that are up to two times higher than that for non-pressure-grouted anchors. These higher adhesion values must be verified by load testing.

Soil conditions, soil-grout adhesion strengths, and installation techniques typically vary over any site. This sometimes results in adhesion values that are lower than anticipated.

Therefore, we recommend substantiating the anchor design values by load-testing all tieback anchors. At least two anchors in each soil type encountered should be performance-tested to 200 or 250 percent of the design anchor load to evaluate possible anchor creep depending on whether the anchors are considered to be temporary or permanent, respectively. Wherever possible, the no-load section of these tiebacks should not be grouted until the performance tests are completed. Unfavorable results from these performance tests could require increasing the lengths of the tiebacks. The remaining anchors should be proof-tested to at least 135 percent of their design value before being "locked off." After testing, each anchor should be locked off at a prestress load of 80 to 100 percent of its design load.

If caving or water-bearing soil is encountered, the installation of tieback anchors will be hampered by caving and soil flowing into the holes. It will be necessary to case the holes, if such conditions are encountered. Alternatively, the use of a hollow-stem auger with grout pumped through the stem as the auger is withdrawn would be satisfactory, provided that the injection pressure and grout volumes pumped are carefully monitored.

All drilled installations should be grouted and backfilled immediately after drilling. No drilled holes should be left open overnight.

Landslide Catchment Wall

As noted earlier, there is a potential for landslides to occur on the steep slope above the proposed residence, especially during/following times of excessive precipitation. It has been common to mitigate the potential of the hazard of landslides in this area by constructing a reinforced retaining (catchment) wall on the side of developments that are exposed to steep slopes. Such a wall would extend above the ground level of the development.

A steep slope rises above the north side of the proposed eastern residence. Based on our experience with similar projects, it is our opinion that a minimum catchment height of 4 feet should be provided. This portion of the wall should not have penetrations such as doors or windows. An active equivalent fluid pressure of 100 pounds per cubic foot (pcf) should be used in the design of the catchment wall to account for the impact force. It will likely be necessary to remove accumulated material periodically. The removal of small amounts of material could be accomplished by hand. The freeboard of the catchment wall must be maintained for the wall to provide continued protection from landslides.

The following plates are attached to complete this letter:

Plate 1	Site Exploration Plan
Plates 2 - 3	Test Boring Logs
Plate 4	Tied-Back Shoring Detail
Plate 5	Typical Shoring Drain Detail

Please contact us if you have any questions regarding this letter or if we can be of further assistance.

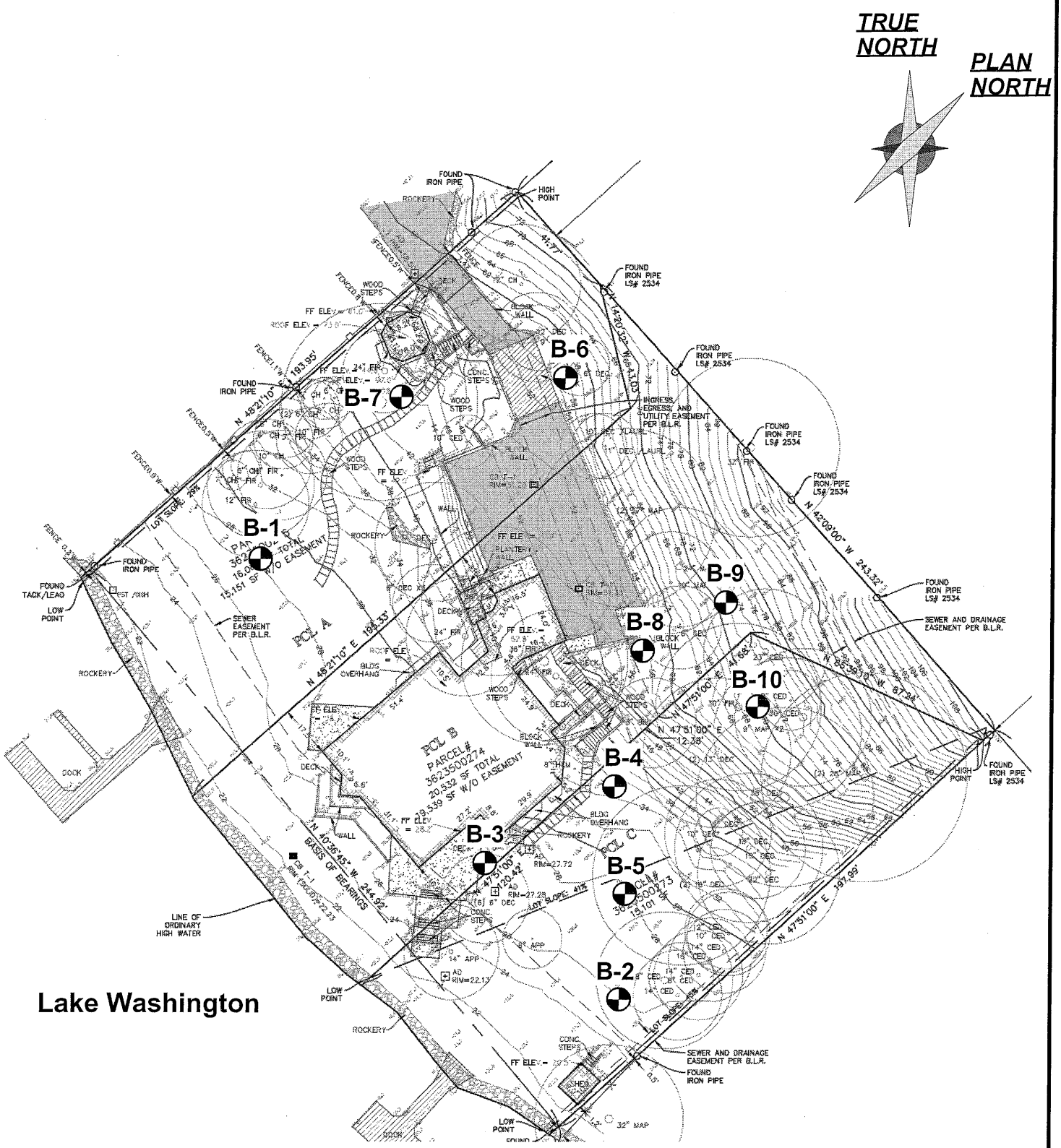
Respectfully submitted,

GEOTECH CONSULTANTS, INC.

Marc R. McGinnis, P.E.
Principal

cc: **Demetriou Architects** – Andrea Smith
via email: abs@demetriou.net

TRC/MRM: mw



Legend:

- Test Boring Location

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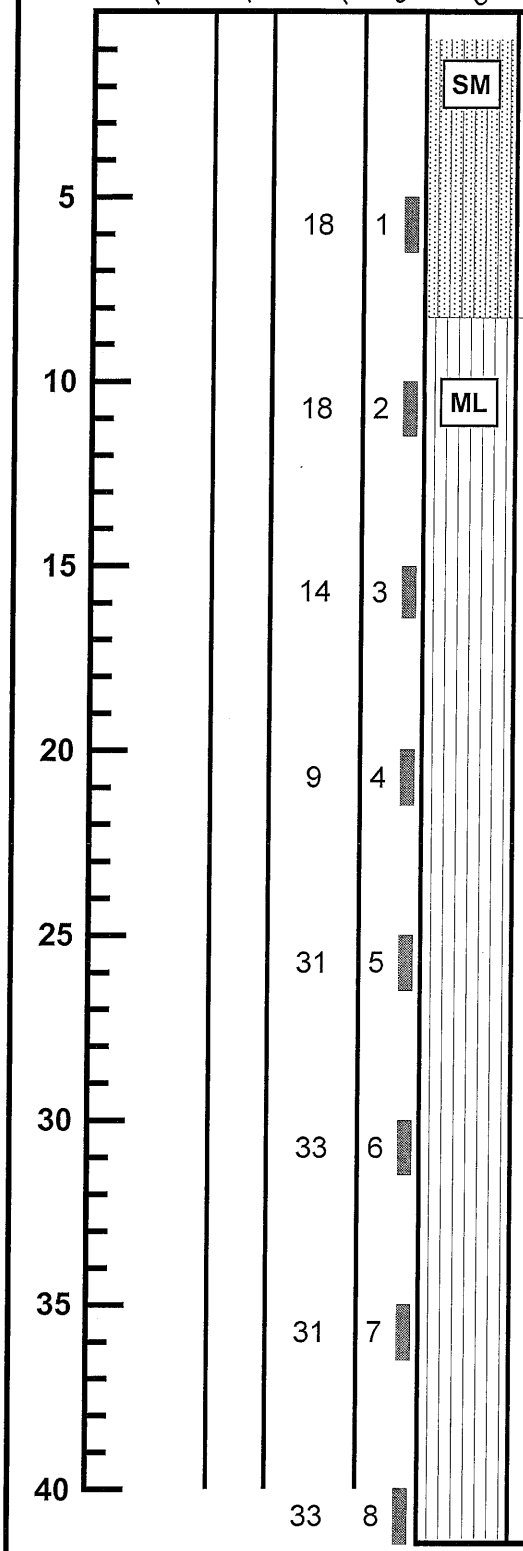
SITE EXPLORATION PLAN

3675 West Mercer Way
Mercer Island, Washington

Job No:	Date:		Plate:
16543	Sept. 2017	No Scale	1

BORING 9



Description

Topsoil over:
Gray-brown silty SAND, fine-grained, moist, loose to medium-dense

-becomes medium-dense

Gray-brown SILT to sandy SILT, fine-grained, non-plastic, very moist, medium-dense

-with clayey zones

-becomes clayey, slightly plastic, and stiff

-becomes non-plastic and dense

-with clayey zones

*** Test boring terminated at 41.5 ft on Sept 14, 2017. No groundwater seepage encountered during drilling.**

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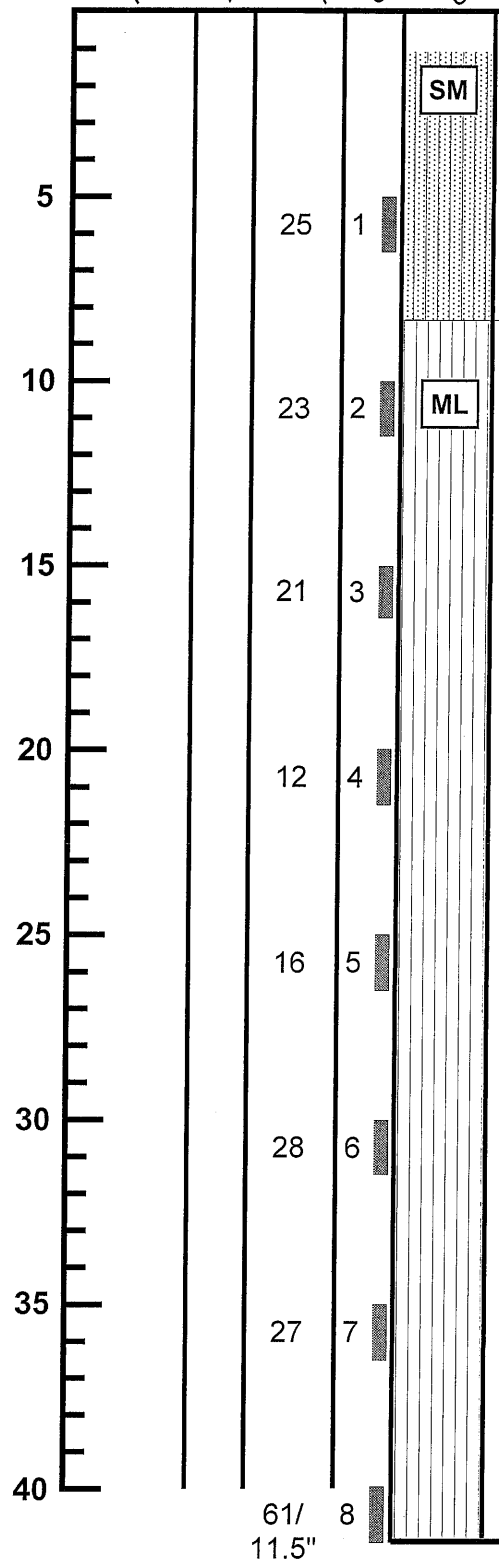
BORING LOG

3675 West Mercer Way
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
16543	Sept. 2017	TRC	2

BORING 10



Description

Topsoil over:

Gray-brown silty SAND, fine-grained, moist, loose to medium-dense

-becomes medium-dense

Gray-brown SILT, non-plastic, very moist, medium-dense

-becomes clayey, slightly plastic, and stiff

-becomes non-plastic and medium-dense

-overstated blows

*** Test boring terminated at 41.5 ft on Sept 14, 2017. No groundwater seepage encountered during drilling.**

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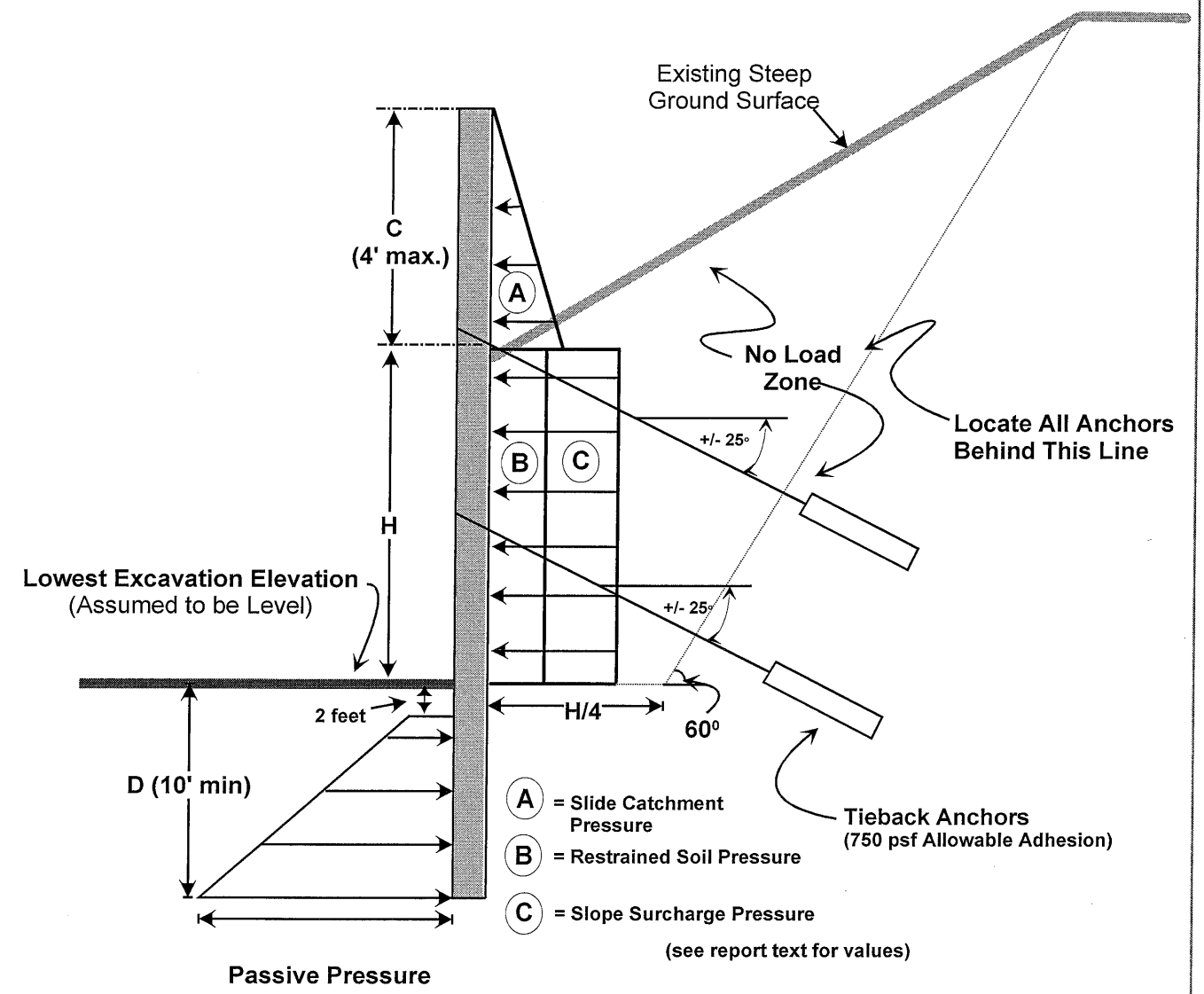
BORING LOG

3675 West Mercer Way
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
16543	Sept. 2017	TRC	3



Notes:

(1) The report should be referenced for specifics regarding design and installation.
(2) Active pressures act over the pile spacing.
(3) Passive pressures act over twice the grouted soldier pile diameter or the pile spacing, whichever is smaller.
(4) It is assumed that no hydrostatic pressures act on the back of the shoring walls.
(5) Cut slopes or adjacent structures positioned above or behind shoring will exert additional pressures on the shoring wall.

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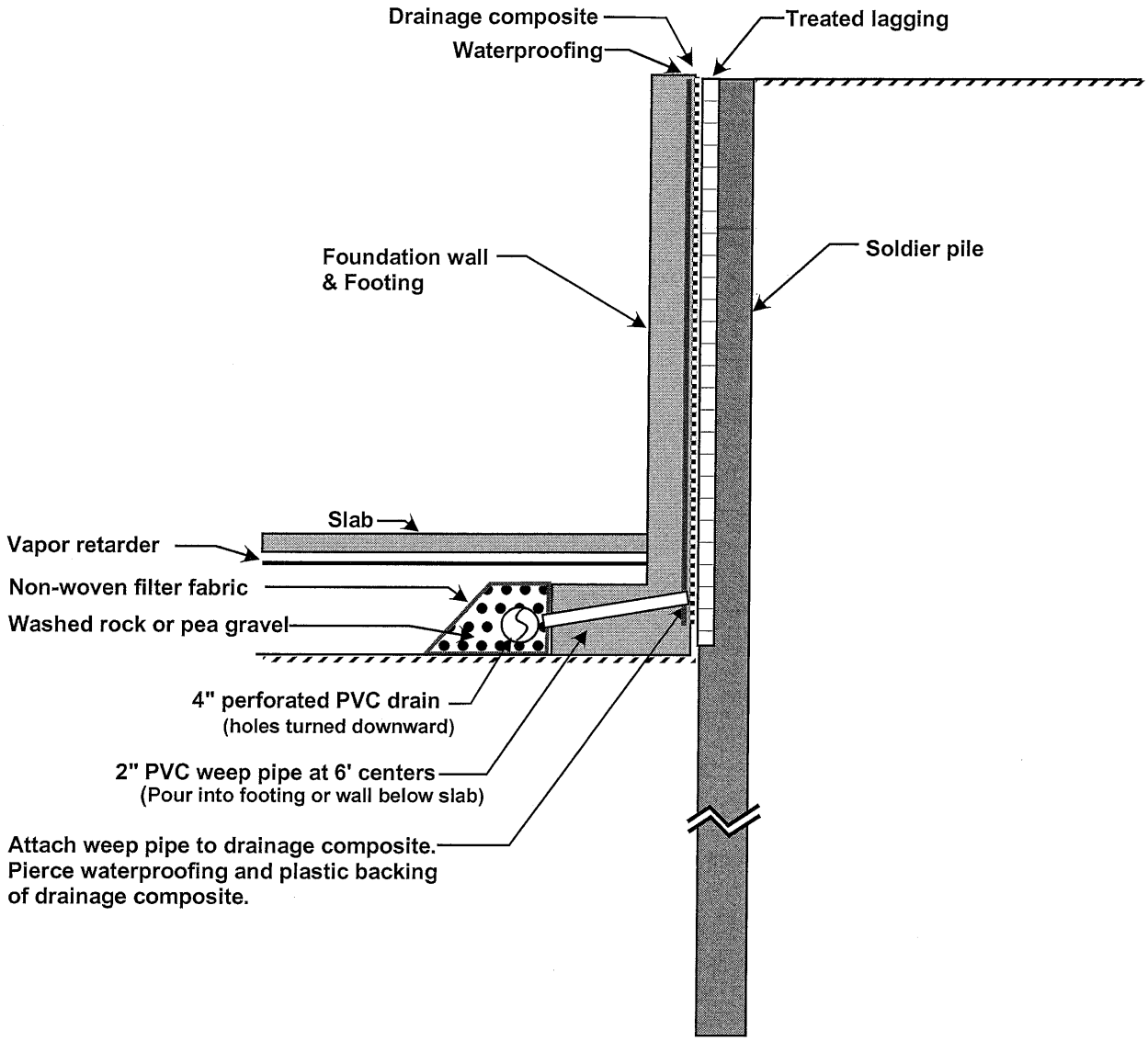
Tied-Back Shoring Detail
3675 West Mercer Way
Mercer Island, Washington

Job No:	Date:		Plate:
16543	Sept. 2017		4



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

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SHORING DRAIN DETAIL

3675 West Mercer Way
Mercer Island, Washington

Job No:	Date:		Plate:
16543	Sept. 2017		5