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JN 20322

Aaron and Amelia McLear
9210 Southeast 50th Street
Mercer Island, Washington 98040
via email: *aaronmclear@gmail.com* *&* *ameliamclear12@gmail.com*

Subject: **Transmittal Letter – Geotechnical Engineering Study and Critical Area Study**
Proposed Additions to Existing McLear Residence
9120 Southeast 50th Street
Mercer Island, Washington

Dear Mr. and Mrs. McLear:

Attached to this transmittal letter is our geotechnical engineering report for the proposed additions to your existing residence 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, critical area (geologically hazardous area) considerations, and design considerations for foundations, retaining walls, subsurface drainage, and temporary excavations. This work was authorized by your acceptance of our proposal, P-10656 dated August 3, 2020.

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

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

Adam S. Moyer
Geotechnical Engineer

cc: **Brandt Design Group** – Bree Medley
via email: *bree@brandtdesigninc.com*

ASM/MRM:kg

GEOTECHNICAL ENGINEERING STUDY AND CRITICAL AREA STUDY
Proposed Additions to Existing McLear Residence
9120 Southeast 50th Street
Mercer Island, Washington

This report presents the findings and recommendations of our geotechnical engineering study for the site of the proposed additions to the existing McLear residence in Mercer Island. The scope of the Critical Area Study is intended to satisfy the requirements of section 19.07.110 of the Mercer Island City Code (MICC), for geologically hazardous areas.

We were provided with preliminary plans developed by Brandt Design Group, and a topographic survey developed by Terrane and dated April 10, 2020. Based on these plans, we understand that deck off the northern side of the residence's main floor will be demolished and be replaced, with living space (exercise room, expansion of existing bedroom, and a new bedroom) at the basement level beneath the reconstructed deck. The exercise room will extend northward from the existing basement "playroom" located in the northeast corner of the basement into an existing concrete patio, but will be smaller than the footprint of the patio or the main floor deck above. The north wall of the exercise room will extend to the top of the steep slope, at the northern edge of the existing patio. Isolated columns supporting the reconstructed main floor deck will be located to the east and west of the exercise room. To the west of the playroom and planned exercise room, the north wall of an existing bedroom will be expanded approximately 5 feet toward the north. The existing basement room to the west of this current bedroom will also be converted to a new bedroom. The north walls of both bedrooms will be set back at least 10 feet from the steep slope.

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 in Mercer Island. The subject lot is roughly rectangular in shape with a narrow panhandle which extends west off its northwest corner that contains the driveway connecting the site to the eastern end of Southeast 50th Street to the west. The property is located at the top of a tall very steep slope that descends to the north, northeast, and southeast. From the toe of this very steep slope, the grade continues to descend moderately downwards towards East Mercer Way. The northwestern quadrant of the subject site is relatively flat; however, the ground surface slopes gently downwards to the northeast, east, and southeast. A one-story single-family residence is located on the gently-sloped northwestern portion of the property. A basement floor underlies the northeast corner of the residence; the basement daylights to a concrete patio to the northeast. A wooden deck off the main floor extends both north and east of the residence footprint. The top of the aforementioned tall steep slope is located along the northeastern edge of the deck and concrete patio. A small, wooded yard area extends east and south from the residence to the top of the very steep slope, which wraps around the property. Based on the provided topographic survey of the subject site, and the contour lines on the City of Mercer Island's online GIS mapping tool, the steep slope has a height of approximately 80 feet at an inclination of 75 to 80 percent. The steep slope continues across the property lines onto the downslope neighboring properties.

The subject site is mapped on the City of Mercer Island's online GIS tool as being located within/containing several geologically hazardous areas. Excluding the northwest panhandle, the subject site is mapped within a seismic hazard area, erosion hazard area, and a landslide hazard area. Specifically, the tall slope that wraps around the northern, eastern, and southern perimeters of the site are mapped as a "steep slope". A steep slope is defined by Mercer Island Code (MICC) as any slope of 40 percent or greater calculated my measuring the vertical rise over any 30-foot horizontal run.

We did not observe any indications of recent deep-seated slope instability on or around the site during our recent visit to the property. On the Mercer Island Landslide Hazard Map (Troost and Wisher, 2009) the steep slope that wraps around the subject site is indicated as the top of a potential ancient landslide scarp. However, our review of topographic and geotechnical information within our files and the Mercer Island GIS indicates that the steep slopes were more likely caused by erosion of the sandy soils by heavy runoff from the upper portion of Mercer Island as the last glaciers receded from the area over 10,000 years ago. The incised ravine and steep slope features to the north and south of the site do not seem to represent large arcuate shapes more indicative of the large-scale slide masses that are present on the large ancient slide masses on the southern end of Mercer Island. Also, review of exploration logs for the properties downslope of the site have not found significant deposits of landslide debris, unlike the areas below the old landslide scarps in the Avalon and Forest Avenue areas of the Island.

The subject site is surrounded by residential properties containing single-family residences. All of the neighboring residences have large offsets from the subject site.

SUBSURFACE

The subsurface conditions 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 test borings were drilled on October 16, 2020 using a portable Acker drill. This drill system utilizes a small, gasoline-powered engine to advance a hollow-stem auger to the sampling depth. Samples were taken at approximate 2.5- or 5-foot intervals with a standard penetration sampler. This split-spoon sampler, which has a 2-inch outside diameter, is driven into the soil with a 140-pound hammer falling 30 inches. The number of blows required to advance the sampler a given distance is an indication of the soil density or consistency. A geotechnical engineer from our staff observed the drilling process, logged the test borings, and obtained representative samples of the soil encountered. The Test Boring Logs are attached as Plates 3 and 4.

<u>Soil Conditions</u>

Geologic maps for the site and vicinity indicate that the top of the steep slope is underlain by glacial till, a glacially-compressed mixture of gravel, silt, and fine-grained sand. The glacial till is underlain by advance sand and gravel, which was also glacially compressed. The findings of our borings are consistent with the geologic mapping.

The three test borings conducted in the area of the proposed additions off the northern end of the existing residence. Test Boring 2 was conducted near the planned northern wall of the two bedrooms to be created west of the existing playroom/new exercise room. This area was obviously excavated down during the original house construction, as very dense native silty sand with gravel was revealed at a shallow depth beneath the existing concrete patio and a thin layer of slab subgrade material. This very dense silty sand was deposited and compressed during the last glaciation, and is referred to geologically as glacial till.

Test Borings 1 and 3 were conducted along the top of the tall steep slope to the northeast of the patio/deck, and encountered 4.5 feet of loose silty sand fill soils and native silty sand beneath the ground surface. A dense glacial till was encountered beneath 4.5 feet, overlying dense to very dense gravelly sand (glacial outwash). The very dense conditions caused drilling refusal for the portable gas-powered Acker drill at depths of 6.4 to 7 feet.

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

No groundwater seepage was observed in our subsurface explorations. The test borings were left open for only a short time period, but we do not expect that significant groundwater would be present in the outwash soils until far downslope, possibly beyond East Mercer Way.

It should be noted that groundwater levels vary seasonally with rainfall and other factors. We anticipate that limited amounts of groundwater could be found in the loose near-surface soils, perched on top of the underlying denser, glacially-compressed soils. Groundwater is commonly found perched on top of glacially-compressed soils in the Puget Sound region. However, considering the location of the planned additions downslope of the existing house's drainage system, we do not expect significant subsurface water to be found within the expected excavation depths.

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

CRITICAL AREAS STUDY (MICC 19.07)

Seismic Hazard and Potential Landslide Hazard Areas: With the exception of the panhandle in its northwest corner, the entire subject site is located within a mapped Seismic Hazard Area and a Potential Landslide Hazard area. Both geologic hazard areas cover the general vicinity that slopes downward to the east to Lake Washington. As previously discussed, the core of the subject site consists of dense to very dense, glacially compressed, native, glacial till and glacial outwash sands that have a low potential for deep-seated landslides. The mapping of the Potential Landslide Hazard Area is due to the inference by geologists that the steep slope that wraps around the northern, eastern, and southern sides of the property are the top of a headscarp from an ancient landslide, which most likely occurred following the recession of the last glaciers approximately 13,000 years ago. No recent large-scale movement has been documented in this area. Shallow slides will occur periodically on the steep slopes, as the near-surface soil weather and loosen over time, and then are subjected to periods of heavy precipitation. As discussed above it is more likely than not that the steep slopes have been created mostly by erosion from heavy post-glacial runoff, rather than deep-seated slope movement. The recommendations of this report are intended to mitigate the Potential Landslide Hazard.

The proposed development will be supported on foundations bearing on the glacially compressed soils which are not liquefiable, due to their dense nature and the absence of near-surface groundwater. This mitigates the Seismic Hazard.

Steep Slope Hazard Areas: Based on the provided topographic map of the subject site and Mercer Island's GIS tool, the northern, eastern, and southern perimeters of the property have a ground surface inclination of at least 40 percent over a horizontal distance of 30 feet (which the City of Mercer Island code defines as a Steep Slope). A Steep Slope is a qualification as a Landslide Hazard Area under the Mercer Island Code. The ground surface drops approximately 80 feet over 100 horizontal feet (for an inclination of approximately 80 percent) from the edge of the existing patio residence down the natural slope descending to the northeast across the property line and onto the neighboring property. The proposed additions will be located within the existing development footprint and upslope of the tall steep slope. However, the proposed residence additions will be located within a prescriptive minimum 25-foot buffer for Shallow-Seated Landslide Hazard Areas that extends from the top of the steep slope. It is important to note that the existing deck and residence already encroaches into this minimum 25-foot prescriptive buffer.

As further discussed in this report, the proposed residence additions and replaced deck will be supported on foundations bearing on the dense to very dense glacially-compressed soils beneath the subject site, which are not susceptible to deep-seated movement. However, with any steep slope in the Puget Sound region, there is always the potential for movement of the loose near-surface soils, particularly after extended periods of precipitation. Our recommendations for mitigation of this landslide hazard include: 1) removing the existing fill from the top of the steep slope within the planned exercise room, and 2) supporting the exercise room and deck foundations to be located near the top of the steep slope on driven pipe piles. It is our opinion that no buffers or setbacks are needed from this Steep Slope, provided the recommendations presented in this report are followed. The recommendations presented in the report are intended to prevent adverse impacts to the stability of the slope on the site and the neighboring properties, and to protect the planned development from damage in the event of potential future shallow soil movement on the steep slope. The slope itself should remain undisturbed by the planned work.

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

Buffers and Mitigation: Under MICC 19.07.160(C), a prescriptive buffer of 25 feet is required from all sides of a shallow landslide-hazard area. As noted above, the majority of the subject site lies within a mapped Potential Landslide Hazard Area, and the prescriptive buffer would extend far beyond the boundaries of the planned development area, and into the footprint of the existing house. In our professional opinion, alteration of the prescriptive buffer can be accomplished without adverse impacts to the stability of the steep slope both on, and around the site. No Steep Slope buffer is necessary for the new development, provided the recommendations presented in this report are followed. No buffer is required by the MICC for an Erosion Hazard Area. We recognize that the planned development will occur within the prescriptive buffer upslope of the landslide hazard critical area. The proposed additions will also be located within the existing development footprint.

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 removal of existing fill, installation of pile foundations, appropriate discharge of new storm runoff away from the slope area, and provision of appropriate erosion control measures will mitigate any potential hazards to planned development from 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 alterations 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 dense to very dense glacially compressed silty sand (glacial till) and gravelly sand (glacial outwash) beneath the concrete patio near the existing residence and 6 feet beneath the existing concrete patio along the top of the steep slope to the northeast. Conventional footings constructed on these very dense glacially-compressed soils are appropriate to support the proposed foundations for the north expansion of the basement bedroom spaces. Excavation using a toothed bucket usually leaves several inches of disturbed soils. The loosened soil must be entirely scraped out of the base of the footing excavations. This should be accomplished with a flat-bladed bucket, a grade bar that is dragged with the bucket, or by hand-shoveling the loose soil out of the excavation. The glacial till is silty in nature, and thus very moisture-sensitive. When wet, these soils can become softened from equipment and foot traffic. Therefore, if footings are constructed during wet weather, or when the soils are wet, it may likely be necessary to protect the bearing surfaces with a layer of imported, clean crushed rock to prevent the disturbance of the footing subgrades.

We recommend that the foundations for the exercise room and the northern deck foundations be supported on 3-inch-diameter pipe piles driven into the dense underlying soils. This would eliminate the needed excavation to reach the competent bearing soils below. As discussed above, the existing fill soils will need to be removed underneath the footprint of the planned exercise room. Therefore, the floor will have to be built over a crawl space, as the new lowered grade should not be backfilled.

As previously discussed, the proximity of the development to the tall steep slope to the north will be an important design consideration for the project. The glacially-compressed soils encountered in our test borings, which comprise the core of the steep slope, are not susceptible to deep-seated movement. However, there is always the potential for shallow soil movement on any steep slope in the Puget Sound region. We conducted a slope stability analysis on northern steep slope using the modeling program Slope/W which is developed by GeoSlope. Based on this analysis (attached to the end of this report for reference), we recommend that: 1) the existing fill beneath the footprint of the planned exercise room be removed, and 2) both the exercise room and the new northern deck foundations be supported on 3-inch pipe piles driven into the dense, glacially-compressed soils. As recommended below in the ***Pipe Piles*** section, additional piles should be driven for the foundations along the top of the steep slope to provide added protection in the event of shallow slope movement.

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

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

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

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

SEISMIC CONSIDERATIONS

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

The IBC and ASCE 7 require that the potential for liquefaction (soil strength loss) during an earthquake be evaluated for the peak ground acceleration of the Maximum Considered Earthquake (MCE), which has a probability of occurring once in 2,475 years (2 percent probability of occurring in a 50-year period). The MCE peak ground acceleration adjusted for site class effects (F_{PGA}) equals 0.74g. The soils beneath the site are not susceptible to seismic liquefaction under the ground motions of the MCE because of their dense nature and the absence of near-surface groundwater.

CONVENTIONAL FOUNDATIONS

We recommend that continuous and individual spread footings for the expansion of the basement bedrooms have minimum widths of 12 and 16 inches, respectively. Exterior footings should also be bottomed at least 18 inches below the lowest adjacent finish ground surface for protection against frost and erosion. The local building codes should be reviewed to determine if different footing widths or embedment depths are required. Footing subgrades must be cleaned of loose or disturbed soil prior to pouring concrete. Depending upon site and equipment constraints, this may require removing the disturbed soil by hand.

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

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

Lateral loads due to wind or seismic forces may be resisted by friction between the foundation and the bearing soil, or by passive earth pressure acting on the vertical, embedded portions of the foundation. For the latter condition, the foundation must be either poured directly against relatively level, undisturbed soil or be surrounded by level, well-compacted fill.

We recommend using the following ultimate values for the foundation's resistance to lateral loading:

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

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

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

PIPE PILES

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

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

> **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, 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 for 3-inch-diameter piles. 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.

Considering the competent nature of the on-site soils, and the extensive amount of knowledge developed from pipe pile installation in these soils over the past 30 years, it is our opinion that load tests are not required to verify the above-recommended capacity.

Pile caps and grade beams should be used to transmit loads to the piles. For added protection of the new foundations in the event of future shallow slope movement, we recommend that the piles for the north wall of the exercise room be spaced at no more than 3 feet on-center and every other pile be driven with a 1:5 (Horizontal: Vertical) batter down toward the north. The two isolated deck footings east and west of the exercise room should be supported on a minimum of two pipe piles, with one of the piles being battered down toward the north at a 1:5 (H:V) inclination.

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.

FOUNDATION AND RETAINING WALLS

No significant new retaining walls are expected for this project. 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 *	35 pcf
Passive Earth Pressure	300 pcf
Coefficient of Friction	0.50
Soil Unit Weight	130 pcf

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

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

The design values given above do not include the effects of any hydrostatic pressures behind the walls and assume that no surcharges, such as those caused by slopes, vehicles, or adjacent foundations will be exerted on the walls. If these conditions exist, those pressures should be added to the above lateral soil pressures. Where sloping backfill is desired behind the walls, we will need to be given the wall dimensions and the slope of the backfill in order to provide the appropriate design earth pressures. The surcharge due to traffic loads behind a wall can typically be accounted for by adding a uniform pressure equal to 2 feet multiplied by the above active fluid density. Heavy construction equipment should not be operated behind retaining and foundation walls within a distance equal to the height of a wall, unless the walls are designed for the additional lateral pressures resulting from the equipment.

The values given above are to be used to design only permanent foundation and retaining walls that are to be backfilled, such as conventional walls constructed of reinforced concrete or masonry. It is not appropriate to use the above earth pressures and soil unit weight to back-calculate soil strength parameters for design of other types of retaining walls, such as soldier pile, reinforced earth, modular or soil nail walls. We can assist with design of these types of walls, if desired.
The passive pressure given is appropriate only for a shear key poured directly against undisturbed native soil, or for the depth of level, well-compacted fill placed in front of a retaining or foundation wall. The values for friction and passive resistance are ultimate values and do not include a safety factor. Restrained wall soil parameters should be utilized the wall and reinforcing design for a distance of 1.5 times the wall height from corners or bends in the walls, or from other points of restraint. This is intended to reduce the amount of cracking that can occur where a wall is restrained by a corner.

Wall Pressures Due to Seismic Forces

Per the IBC Section 1803.5.12, a seismic surcharge load is only needed for walls over 6 feet tall. 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 8**H** pounds per square foot (psf), where **H** is the design retention height of the wall. Using this increased pressure, the safety factor against sliding and overturning can be reduced to 1.2 for the seismic analysis.

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. Drainage composite similar to Miradrain 6000 should be placed against the backfilled retaining walls. The drainage composites should be hydraulically connected to the foundation drain system. Free-draining backfill should be used for the entire width of the backfill where seepage is encountered. For increased protection, drainage composites should be placed along cut slope faces, and the walls should be backfilled entirely with free-draining soil. The later section entitled ***Drainage Considerations*** should also be reviewed for recommendations related to subsurface drainage behind foundation and retaining walls.

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

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

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

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

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

FLOOR SLABS

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

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

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

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

The ***General***, ***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

Temporary excavation slopes should not exceed the limits specified in local, state, and national government safety regulations. Also, temporary cuts should be planned to provide a minimum 2 to 3 feet of space for construction of foundations, walls, and drainage. Temporary cuts to a maximum overall 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. Unless approved by the geotechnical engineer of record, it is important that vertical cuts not be made at the base of sloped cuts. Based upon Washington Administrative Code (WAC) 296, Part N, the 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 2:1 (H:V). 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. 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 6. 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.

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

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 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. 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, 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.

The allowable thickness of the fill lift will depend on the material type selected, the compaction equipment used, and the number of passes made to compact the lift. The loose lift thickness should not exceed 12 inches, but should be thinner if small, hand-operated compactors are used. We recommend testing structural fill as it is placed. If the fill is not sufficiently compacted, it should be recompacted before another lift is placed. This eliminates the need to remove the fill to achieve the required compaction.

The following table presents recommended levels of relative compaction for compacted fill:

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

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

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

LIMITATIONS

The conclusions and recommendations contained in this report are based on site conditions as they existed at the time of our exploration and assume that the soil and groundwater conditions encountered in the 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 additions 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 additions.

This report has been prepared for the exclusive use of Aaron and Amelia McLear and their 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 Boring Logs
Plate 5	Typical Footing Drain Detail
Attachment	Slope Stability Analysis

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.

Adam S. Moyer
Geotechnical Engineer

MARC R. McGINNIS
STATE OF WASHINGTON
27845
REGISTERED
PROFESSIONAL ENGINEER
1/29/2021

Marc R. McGinnis, P.E.
Principal

ASM/MRM:kg

NORTH

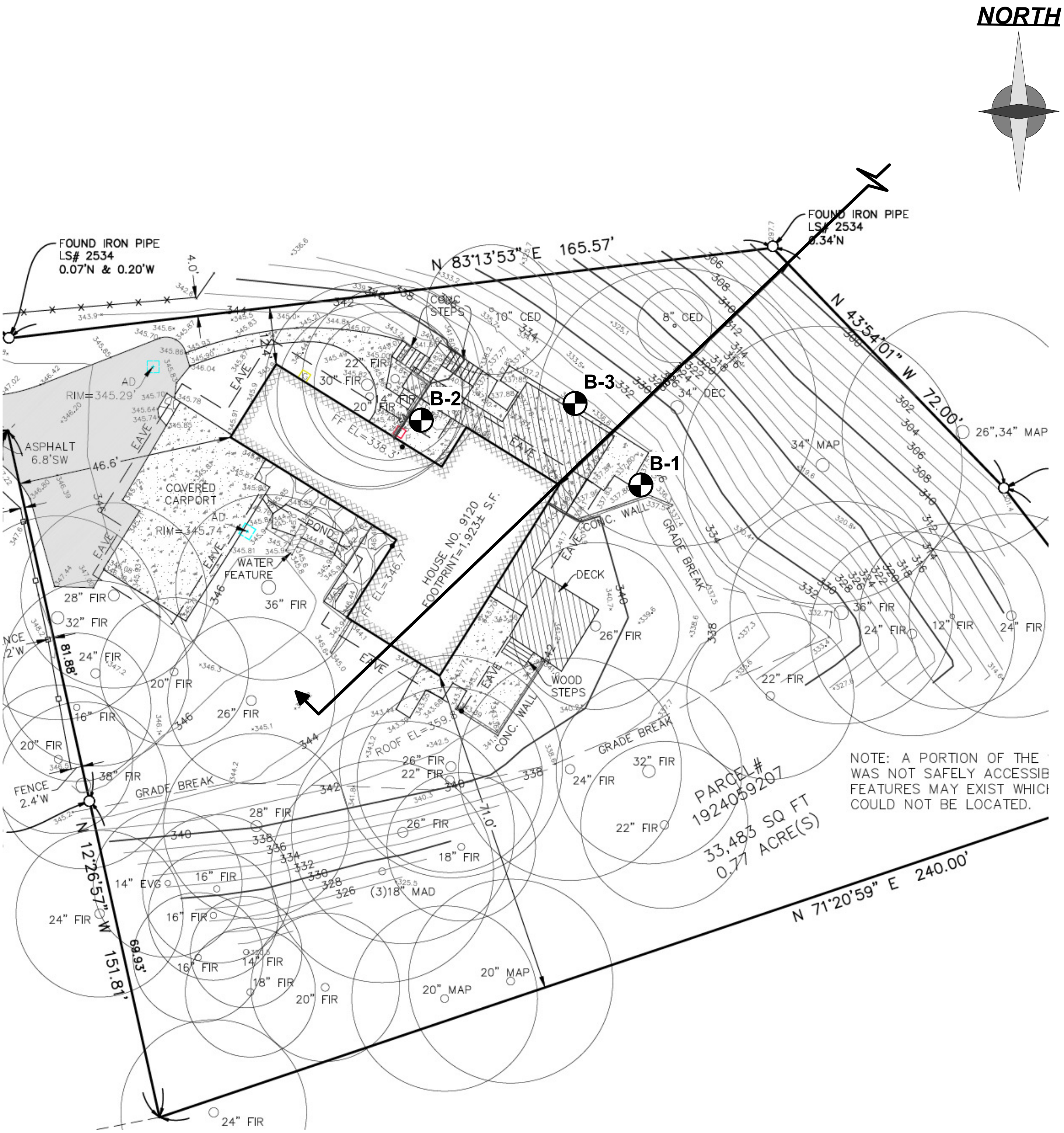
(Source: Microsoft MapPoint, 2013)

GEOTECH CONSULTANTS, INC.

VICINITY MAP

9120 Southeast 50th Street
Mercer Island, Washington

Job No:	Date:		Plate:
20322	Dec. 2020		1



Legend:

Test Boring Location

Slope Cross Section

GEOTECH
CONSULTANTS, INC.

SITE EXPLORATION PLAN

9120 Southeast 50th Street
Mercer Island, Washington

Job No:	Date:		Plate:
20322	Dec. 2020	No Scale	2

BORING 1

Elev. ±337.5 feet

Depth (ft.)	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
0–4.5			14	1	FILL	Gray-brown gravelly silty SAND with pockets of organics, fine-grained, dry, medium-dense **(FILL)**
4.5–5.6			46	2	SM	Gray-brown silty SAND with gravel, fine-grained, moist, very dense **(Glacial Till)**
5.6–6.4			50/2"	3	SP	Gray-brown gravelly SAND with silt, fine- to medium-grained, moist, very dense
			50/2"	4		

*** Test boring was terminated at 6.4 feet on October 16, 2020 due to refusal.**
*** No groundwater was encountered during drilling.**

BORING 2

Elev. ±338 feet

Depth (ft.)	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
0–3.0			85	1	SM	4 inches concrete over: Gray-brown silty SAND with gravel, fine-grained, moist, very dense **(Glacial Till)**

*** Test boring was terminated at 3.0 feet on October 16, 2020 due to refusal.**
*** No groundwater was encountered during drilling.**

GEOTECH
CONSULTANTS, INC.

TEST BORING LOG

9120 Southeast 50th Street
Mercer Island, Washington

Job No:	Date:	Logged by:	Plate:
20290	Dec. 2020	ASM	3

BORING 3

Elev. ±336 feet

Depth (ft.)	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
					FILL	Dark-brown silty SAND with gray-brown SAND, fine-graind, dry, loose (**FILL**)
			9	1	SM	Gray-brown with rust mottling, silty SAND with gravel, fine-grained, dry, loose
5			76	2	SP	Gray-brown gravelly SAND with trace silt, fine- to medium-grained, moist, very dense
			45	3		
10						
15						

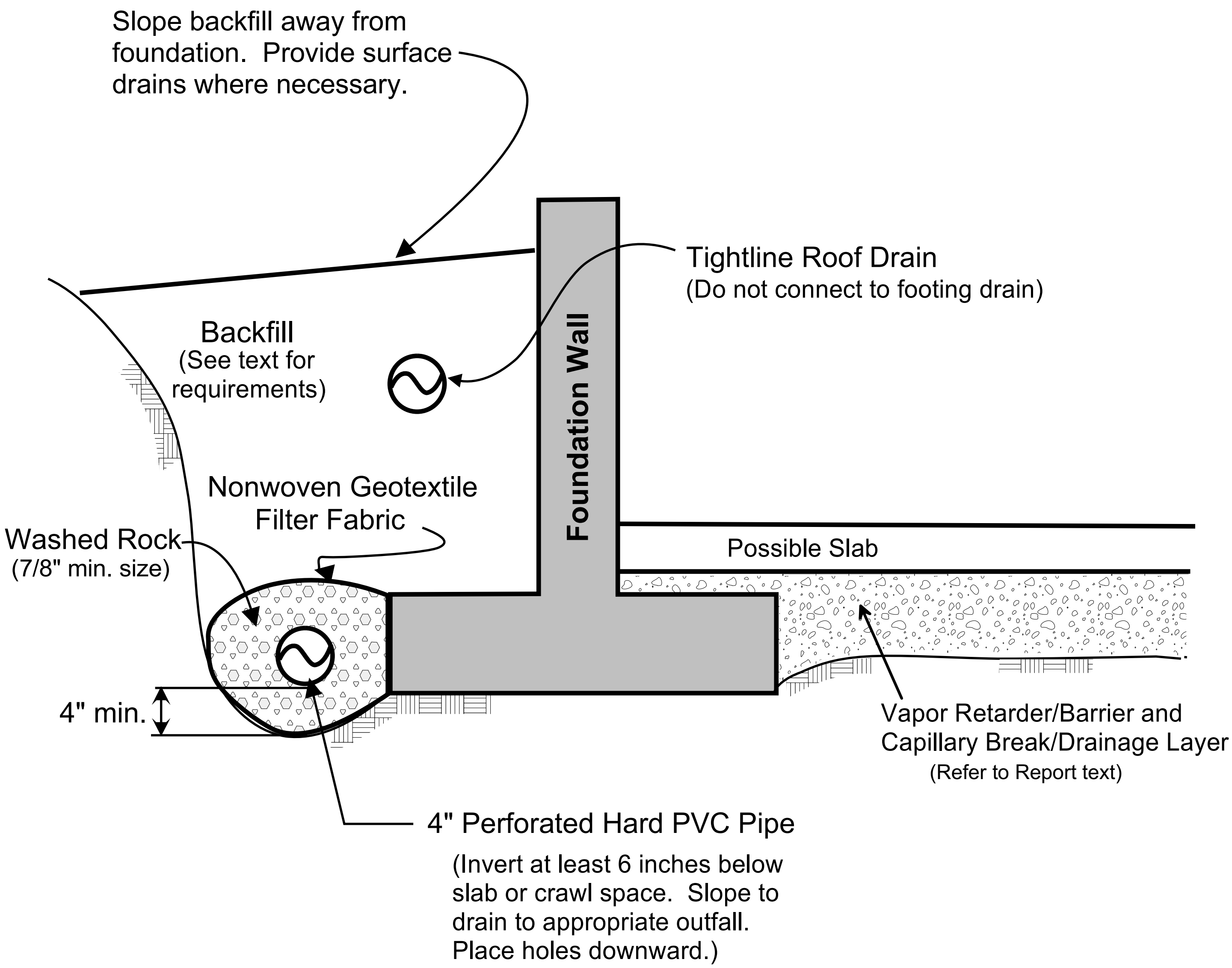
*** Test boring was terminated at 7.0 feet on October 16, 2020 due to refusal.**
*** No groundwater was encountered during drilling.**

GEOTECH
CONSULTANTS, INC.

TEST BORING LOG

9120 Southeast 50th Street
Mercer Island, Washington

Job No:	Date:	Logged by:	Plate:
20290	Dec. 2020	ASM	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.

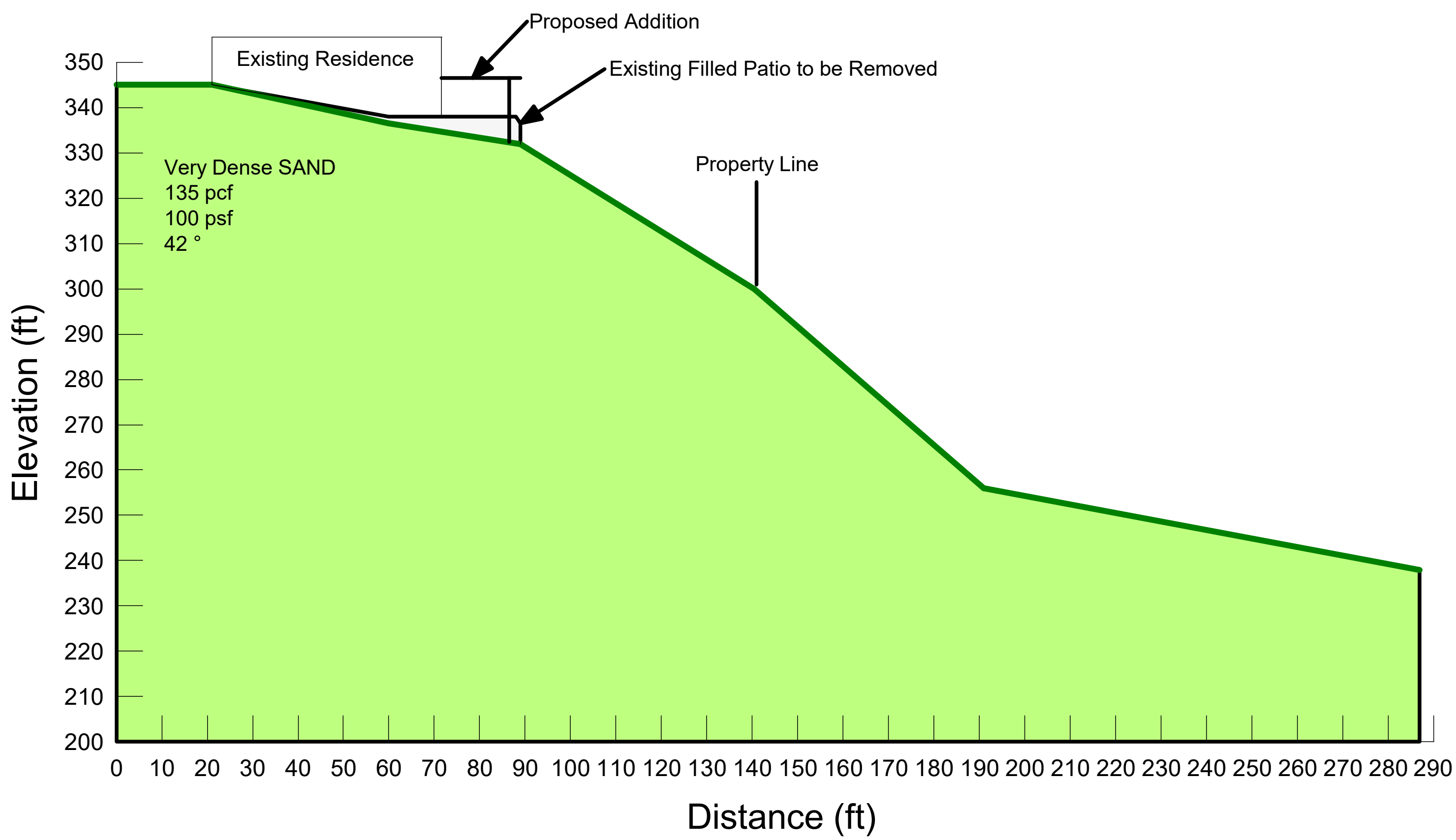
GEOTECH CONSULTANTS, INC.

FOOTING DRAIN DETAIL

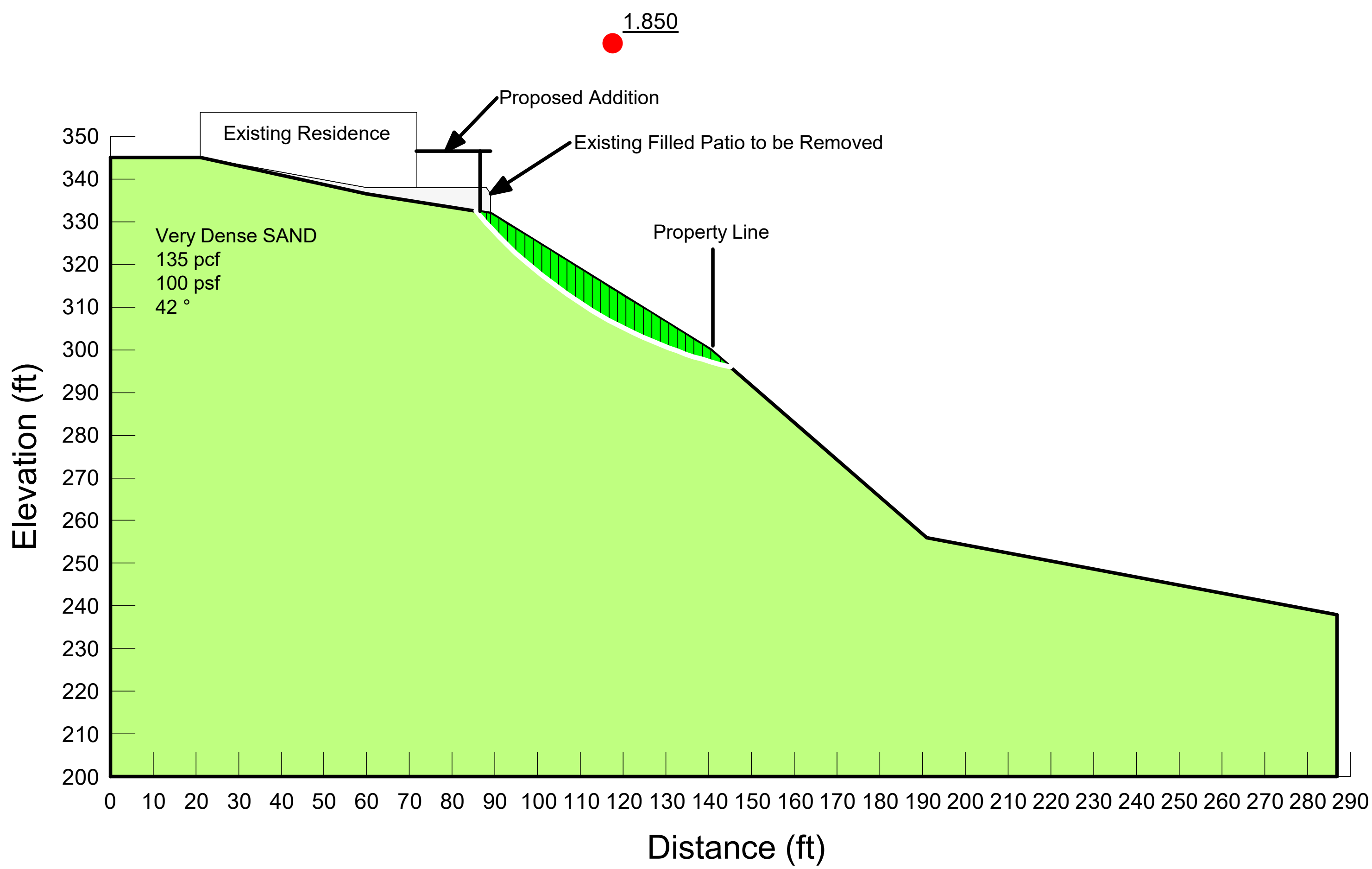
9120 Southeast 50th Street
Mercer Island, Washington

Job No:	Date:		Plate:
20322	Dec. 2020		5

Cross Section



Static


1.850
Proposed Addition
Existing Residence
Existing Filled Patio to be Removed
Property Line
Very Dense SAND
135 pcf
100 psf
42 °
Elevation (ft)
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290
Distance (ft)

Static

File Information

File Version: 8.15
Title: 20322 Slope Stability Analysis
Created By: Adam Moyer
Last Edited By: Adam Moyer
Revision Number: 50
Date: 1/21/2021
Time: 4:31:12 PM
Tool Version: 8.15.6.13446
File Name: 20322 Slope Stability Analysis.gsz
Directory: C:\Users\AdamM\Geotech Consultants\Shared Documents - Documents\2020 Jobs\20322 McLear (MRM)\
Last Solved Date: 1/21/2021
Last Solved Time: 4:31:16 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Static

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: (none)

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Very Dense SAND

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 100 psf
Phi': 42 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (71.5, 334.71552) ft
Left-Zone Right Coordinate: (89, 332) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (135.97044, 302.81448) ft
Right-Zone Right Coordinate: (145.09091, 296) ft
Right-Zone Increment: 20
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 345) ft
Right Coordinate: (287, 238) ft

Points

	X (ft)	Y (ft)
Point 1	0	345
Point 2	21	345
Point 3	71.5	338

Point 4	88	338
Point 5	89	336.5
Point 6	60	338
Point 7	140.5	300
Point 8	191	256
Point 9	287	238
Point 10	287	200
Point 11	0	200
Point 12	60	336.5
Point 13	89	335
Point 14	89	332
Point 15	89	329.5

Regions

	Material	Points	Area (ft^2)
Region 1	Very Dense SAND	1,2,12,14,7,8,9,10,11	26,853
Region 2		14,13,5,4,3,6,2,12	137.25

Current Slip Surface

Slip Surface: 3,919

F of S: 1.850

Volume: 342.1631 ft^3

Weight: 46,192.019 lbs

Resisting Moment: 4,806,703.6 lbs-ft

Activating Moment: 2,597,867.2 lbs-ft

Resisting Force: 37,004.639 lbs

Activating Force: 20,002.564 lbs

F of S Rank (Analysis): 1 of 4,851 slip surfaces

F of S Rank (Query): 1 of 4,851 slip surfaces

Exit: (145.09091, 296) ft

Entry: (85.5, 332.5431) ft

Radius: 110.73584 ft

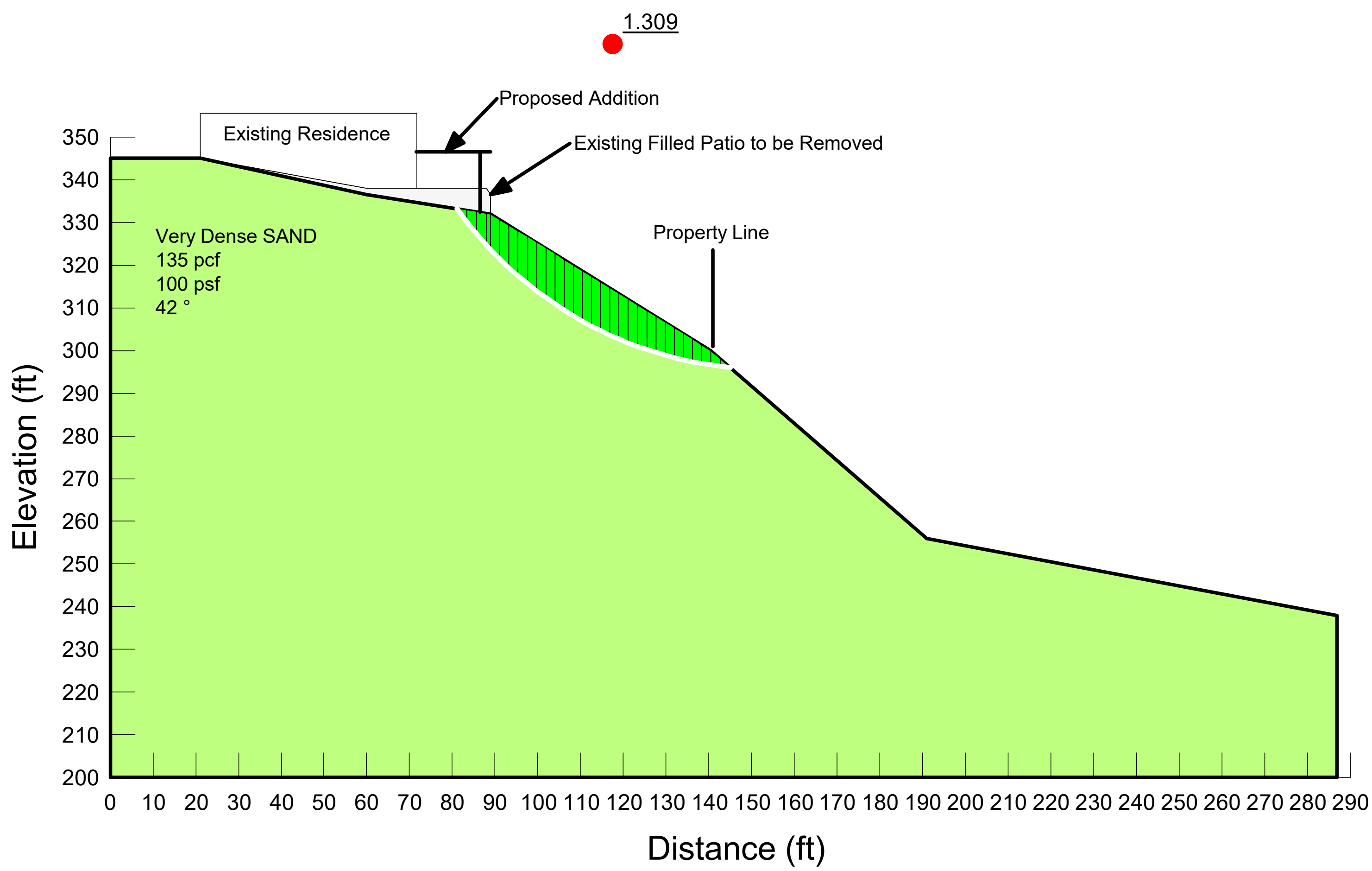
Center: (170.22526, 403.84568) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	86.75	331.10857	0	68.199928	61.407491	100
Slice 2	88.5	329.12714	0	215.54025	194.07331	100
Slice 3	89.990385	327.53889	0	290.2306	261.3248	100
Slice 4	91.971154	325.50819	0	356.41175	320.91458	100
Slice 5	93.951923	323.57776	0	415.12283	373.77828	100
Slice 6	95.932692	321.74052	0	467.94867	421.34287	100
Slice 7	97.913462	319.99033	0	516.10901	464.70664	100
Slice 8	99.894231	318.32183	0	560.51696	504.69173	100
Slice 9	101.875	316.73033	0	601.82108	541.88213	100

Slice 10	103.85577	315.21168	0	640.43536	576.65059	100
Slice 11	105.83654	313.76218	0	676.55927	609.1767	100
Slice 12	107.81731	312.37854	0	710.18993	639.45788	100
Slice 13	109.79808	311.05783	0	741.12914	667.31567	100
Slice 14	111.77885	309.79737	0	768.98837	692.40024	100
Slice 15	113.75962	308.59479	0	793.19559	714.19652	100
Slice 16	115.74038	307.44791	0	813.00775	732.03546	100
Slice 17	117.72115	306.35476	0	827.53273	745.11382	100
Slice 18	119.70192	305.31355	0	835.76396	752.52525	100
Slice 19	121.68269	304.32266	0	836.62997	753.30501	100
Slice 20	123.66346	303.38059	0	829.0598	746.4888	100
Slice 21	125.64423	302.48598	0	812.06245	731.18431	100
Slice 22	127.625	301.63759	0	784.81568	706.65121	100
Slice 23	129.60577	300.83427	0	746.75586	672.382	100
Slice 24	131.58654	300.07498	0	697.65785	628.17395	100
Slice 25	133.56731	299.35875	0	637.69226	574.18069	100
Slice 26	135.54808	298.6847	0	567.4487	510.93311	100
Slice 27	137.52885	298.05203	0	487.91725	439.32266	100
Slice 28	139.50962	297.46	0	400.42618	360.54535	100
Slice 29	141.64773	296.86746	0	263.84861	237.57035	100
Slice 30	143.94318	296.28043	0	80.524709	72.504774	100

Seismic


1.309
Proposed Addition
Existing Residence
Existing Filled Patio to be Removed
Property Line
Very Dense SAND
135 pcf
100 psf
42 °
Elevation (ft)
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290
Distance (ft)

Seismic

File Information

File Version: 8.15
Title: 20322 Slope Stability Analysis
Created By: Adam Moyer
Last Edited By: Adam Moyer
Revision Number: 50
Date: 1/21/2021
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Directory: C:\Users\AdamM\Geotech Consultants\Shared Documents - Documents\2020 Jobs\20322 McLear (MRM)\
Last Solved Date: 1/21/2021
Last Solved Time: 4:31:14 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Seismic

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Very Dense SAND

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 100 psf
Phi': 42 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (71.5, 334.71552) ft
Left-Zone Right Coordinate: (89, 332) ft
Left-Zone Increment: 20
Right Projection: Range
Right-Zone Left Coordinate: (135.88249, 302.86913) ft
Right-Zone Right Coordinate: (145.09091, 296) ft
Right-Zone Increment: 20
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 345) ft
Right Coordinate: (287, 238) ft

Seismic Coefficients

Horz Seismic Coef.: 0.198

Points

	X (ft)	Y (ft)
Point 1	0	345
Point 2	21	345
Point 3	71.5	338
Point 4	88	338
Point 5	89	336.5
Point 6	60	338
Point 7	140.5	300
Point 8	191	256
Point 9	287	238
Point 10	287	200
Point 11	0	200
Point 12	60	336.5
Point 13	89	335
Point 14	89	332
Point 15	89	329.5

Regions

	Material	Points	Area (ft²)
Region 1	Very Dense SAND	1,2,12,14,7,8,9,10,11	26,853
Region 2		14,13,5,4,3,6,2,12	137.25

Current Slip Surface

Slip Surface: 2,762
F of S: 1.309
Volume: 535.88135 ft³
Weight: 72,343.983 lbs
Resisting Moment: 5,421,609.9 lbs-ft
Activating Moment: 4,141,243.1 lbs-ft
Resisting Force: 52,864.049 lbs
Activating Force: 40,362.636 lbs
F of S Rank (Analysis): 1 of 4,851 slip surfaces
F of S Rank (Query): 1 of 4,851 slip surfaces
Exit: (145.09091, 296) ft
Entry: (81.125, 333.22198) ft
Radius: 89.380103 ft
Center: (154.02809, 384.93216) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	82.270833	331.67803	0	42.969978	38.690342	100
Slice 2	84.5625	328.71813	0	221.58786	199.5186	100
Slice 3	86.854167	325.99619	0	374.85645	337.52227	100
Slice 4	88.5	324.15115	0	475.46516	428.11075	100
Slice 5	90.072917	322.51278	0	529.47654	476.74282	100

Slice 6	92.21875	320.38604	0	578.14717	520.56605	100
Slice 7	94.364583	318.39652	0	623.32494	561.2443	100
Slice 8	96.510417	316.5322	0	667.1826	600.73391	100
Slice 9	98.65625	314.78308	0	711.53008	640.66456	100
Slice 10	100.80208	313.14072	0	757.84601	682.36762	100
Slice 11	102.94792	311.59793	0	807.26458	726.86429	100
Slice 12	105.09375	310.14855	0	860.51979	774.8155	100
Slice 13	107.23958	308.78722	0	917.84962	826.43551	100
Slice 14	109.38542	307.50929	0	978.86573	881.37466	100
Slice 15	111.53125	306.3107	0	1,042.4017	938.58269	100
Slice 16	113.67708	305.18786	0	1,106.365	996.17552	100
Slice 17	115.82292	304.13761	0	1,167.6347	1,051.343	100
Slice 18	117.96875	303.15715	0	1,222.0634	1,100.3508	100
Slice 19	120.11458	302.244	0	1,264.6501	1,138.6961	100
Slice 20	122.26042	301.39594	0	1,289.9349	1,161.4626	100
Slice 21	124.40625	300.61101	0	1,292.6176	1,163.8781	100
Slice 22	126.55208	299.88746	0	1,268.3341	1,142.0132	100
Slice 23	128.69792	299.22374	0	1,214.4407	1,093.4873	100
Slice 24	130.84375	298.61846	0	1,130.6098	1,018.0056	100
Slice 25	132.98958	298.0704	0	1,019.0498	917.55654	100
Slice 26	135.13542	297.57849	0	884.24398	796.17685	100
Slice 27	137.28125	297.14177	0	732.23967	659.31156	100
Slice 28	139.42708	296.75943	0	569.66561	512.92922	100
Slice 29	141.64773	296.42122	0	360.31252	324.42685	100
Slice 30	143.94318	296.13034	0	112.86789	101.6267	100