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March 3, 2016

Fat Boy Construction
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Attn: Mr. Mike Boyle

Geotechnical Engineering Report
Detached Garage
3603 West Mercer Way
Mercer Island, Washington
Parcel No: 3623500260
Doc ID: FatBoyCon.WMercerWay.RG.rev01

INTRODUCTION

As requested, we are pleased to submit this geotechnical engineering report for the detached garage to be constructed at 3603 West Mercer Way, Mercer Island, Washington, as shown on the attached Site Location Map, Figure 1.

Our understanding of the project is based on telephone and email correspondences with you; a review of the proposed site plan and grading plan; our understanding of the City of Mercer Island Critical Areas Ordinance and Site Development codes; and our past experience on the Mercer Island. We understand that you propose to construct a new detached garage. The garage will be constructed at grade with the existing private driveway that bisects the upper, eastern portion of the site. Because of slopes on the site, the garage will be constructed on posts and pilings with a structural deck. A conceptual plan showing the proposed garage configuration is attached as Figure 2.

Once the variance process is completed, we will finalize this report to address any applicable conditions and building department requirements.

SCOPE OF SERVICES

Because of steep slopes on and below the subject parcels, the City of Mercer Island requires a geotechnical engineering report to address critical areas and associated buffers/setbacks from the steep slopes, as well as to provide geotechnical design recommendations for site grading, foundations, floors, pavements, drainage, and structural fill. Prescriptive buffers/setbacks from the slope may affect some of the proposed lots development. Therefore it will be necessary to reduce the buffers and provide mitigation recommendations that will allow buffer reductions. Our services address both the City of Mercer Island requirements and provide site specific design requirements for the other design team partners, including the following:

1. Reviewing existing geological and geotechnical literature for the site area;

2. Exploring subsurface conditions across the site by drilling one hollow-stem auger boring and excavating two hand auger explorations at selected locations across the site;
3. Describing surface and subsurface conditions, including soil type, depth to groundwater, and estimate high groundwater;
4. Addressing the City of Mercer Island Critical Areas Ordinance for the proposed site development;
5. Providing geotechnical conclusions and recommendations regarding site grading activities, including site preparation, subgrade preparation, fill placement criteria, suitability of on-site soils for use as structural fill, temporary and permanent cut and fill slopes, and drainage and erosion control measures;
6. Providing conclusions regarding foundation and floor slab support and design criteria, including bearing capacity and subgrade modulus;
7. Providing recommendations for erosion and sediment control during wet weather grading and construction; and
8. Preparing a written Geotechnical Engineering Report summarizing our site observations and conclusions, and our geotechnical recommendations and design criteria, along with the supporting data.

SITE DESCRIPTION

The site is located at 3603 W. Mercer Way on Mercer Island, Washington. The site s single tax parcel that is irregular in shape, generally measures 50 feet wide (north to south) by 137 to 143 feet deep (east to west), and encompasses about 0.16 acres. The property is bounded by existing residences on the north and south, by Lake Washington on the west, and a private driveway to the east. As shown on the Site & Exploration Plan, Figure 3, prepared by Beyler Consulting (9/11/2014), the site is occupied by an existing single family residence situated on the flatter, lower, western portion of the site. Access to the residence is via a set of wooden stairs and concrete steps. An old tram is located north of the stairs.

As stated, the residence is located on the flatter, lower portion of the site. The site slopes up from the east side of the residence at 65 to 80 percent. The slope levels across the private driveway and continues up at about 80 to 100 percent to a level, gravel parking area with a detached garage. Total height of the slope between the residence and the driveway is about 58 to 60 feet, while the vertical height of the slope above the driveway is 20 to 35 feet. The topography is shown on the attached Site & Exploration Plan, Figure 3.

The slope area is covered with a combination of scattered fir and deciduous trees (alders and maples) with and understory of ferns, ivy, and some blackberries. No seepages or springs were noted on slope, nor were any areas of active or ongoing erosion.

Site Soils

The Natural Resource Conservation Services (NRCS) Web Soil Survey for King County indicates that the site soils consist of the Kitsap silt loam (KpD) soils that form on slopes of 15 to 30 percent. These soils derived from glacial lake sediments, have a moderate to severe erosion hazard, and are listed in hydrologic soil group C. A copy of the SCS soils map for the site area is attached as Figure 4.

Geologic Conditions

The *Geologic Map of Mercer Island, Washington* by Kathy G. Troost and Aaron P. Wisher (October, 2006) indicates that the site is underlain by a sequence of pre-Olympia fine grained, glacial till, and coarse grained deposits deposited more than 70,000 years ago and were subsequently overridden by the more recent Vashon Stade of the Fraser Glaciation approximately 12,000 to 15,000 years ago. The fine grained deposits are typically 10 to 27 meters thick and consists of silt and clay that may have fine sandy inter-beds. This layer is laminated to massive. The coarse grained deposits vary in thickness from 6 to 20 meters and consist of sand and gravel that is generally clean, with some localized silt layers. Both soils types are mapped as being hard to very dense. The underlying pre-Olympia glacial till is a mixture of silt, sandy, and gravel that was deposited and overridden by the pre-Olympia continental ice mass. A excerpt of the referenced geologic map is included as Figure 5.

Subsurface Explorations

On November 3, 2015 a geologist from GeoResources, LLC was onsite and monitored the drilling of a single hollow stem auger boring logged the subsurface conditions, and obtained representative soil samples. The location of the boring was selected by GeoResources personnel in the field based on existing site conditions relative to the proposed development.

Soil samples were obtained at 2½- to 5-foot depth intervals in accordance with Standard Penetration Test (SPT) as per the test method outline by ASTM:D-1586. This method consists of driving a standard 2-inch-diameter split-spoon sampler 18 inches into the soil with a 140-pound hammer. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or "SPT blow count." The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

We returned to the site on November 12, 2015 and excavated two hand auger exploration on the slope between the driveway and the house. The hand auger was excavated using both a post-hole digger and 3-inch hand auger.

The soils encountered in our exploration were visually classified in accordance with the Unified Soil Classification System (USCS), a copy of which is attached as Figure A-1. Collected soil samples were placed in sealed plastic bags and taken to a laboratory for further examination and testing as deemed necessary. The boring was backfilled with bentonite chips upon completion, while hand auger holes were backfilled with the excavated soils.

The attached *Boring Log* (Figure A-2) and *Hand Auger Logs* (Figure A-3) describe the vertical sequence of soils encountered at each location. Where a soil type changed between sample intervals, we estimated the contact depth based on drilling conditions and cuttings. The boring log also indicates the observed blow count, sample number, and approximate depth of each soil sample from the boring. Where encountered, the approximate groundwater depth is depicted on the boring log.

The borings drilled as part of this evaluation indicates the subsurface conditions at specific locations only, as actual subsurface conditions can vary across the site. Furthermore, the nature and extent of any such variation would not become evident until additional explorations are performed or until construction activities have begun. However, based on our experience in the area and extent in our explorations are generally representative of the soils at the site.

Subsurface Conditions

Our boring and hand boring encountered slightly variable subsurface conditions, but generally confirmed the mapped stratigraphy. Boring B-1 encountered about 5 feet of loose to medium dense fine sand with silt that graded to silty find sand. These surficial soils were underlain by 4 feet of hard silt underlain by dense fine sand with silt to silty fine sand. These soils are generally consistent with the pre-Olympia fine grain sediments described above. Our two hand auger explorations, excavated on the slope below the proposed garage, consisted of medium dense to dense fine sand with silt, silty fine sand, and fine sandy silt. These fine grain deposits were encountered to the full depth explored.

Geotechnical laboratory tests were performed on selected samples to determine soil index and engineering properties encountered. Laboratory testing included visual soil classification per ASTM D: 2488, moisture content determinations per ASTM D: 2216 and grain size analyses were performed in accordance with the ASTM D: 422 standard procedures. The results of our two sieve analysis are included in Appendix B.

Groundwater Conditions

No groundwater seepage was observed in our explorations at the time of excavation. Given the mapped stratigraphy, we do anticipate that the site may be prone to a perched groundwater table. Perched groundwater typically develops when the vertical infiltration of precipitation through a more permeable soil is slowed at depth by a deeper, less permeable soil type. We anticipate fluctuations in the local groundwater levels will occur in response to precipitation patterns, off-site construction activities, and site utilization.

Geologic Hazard Areas – City of Mercer Island Title 19.07.060

The City of Mercer Island Critical Areas Designation and Mapping maps identify the site area as being a steep slope area, potential landslide area, historic landslide area, and erosion hazard area.

Slope Stability Analysis

We analyzed the global and internal slope stability of the existing slope geometries using subsurface profile A-A', as shown on Figure C-1. We used the computer program SLIDE version 6.020, from RocScience, 2012, to perform the slope stability analyses. The computer program SLIDE uses a number of methods to estimate the factor of safety (FS) of the stability of a slope by analyzing the shear and normal forces acting on a series of vertical "slices" that comprise a failure surface. Each vertical slice is treated as a rigid body; therefore, the forces and/or moments acting on each slice are assumed to satisfy static equilibrium (i.e., a limit equilibrium analysis). The FS is defined as the ratio of the forces available to resist movement to the forces of the driving mass. An FS of 1.0 means that the driving and resisting forces are equal; an FS less than 1.0 indicates that the driving forces are greater than the resisting forces (indicating failure). We used the Generalized Limit Equilibrium method using the Morgenstern-Price analysis, which satisfies both moment and force equilibrium, to search for the location of the most critical failure surfaces and their corresponding FS. The most critical surfaces are those with the lowest FS for a given loading condition, and are therefore the most likely to move. Based on our analyses, the FS for the current conditions is about 1.8 and 1.2 for static and seismic conditions, respectively. Details of the slope stability analyses for both static and seismic conditions are included in Appendix C.

CONCLUSIONS

Based on our site observations, subsurface explorations and engineering analysis, it is our opinion that parcel, and slope appears to be in a stable conditions. In our opinion, the construction of the proposed garage appears feasible from a geotechnical standpoint, provided the recommendations contained herein are followed.

CONCLUSIONS AND RECOMMENDATIONS

Based on our site observations and data review, subsurface explorations and our engineering analysis, it is our opinion that the proposed residence will have minimal impacts to the site and adjacent properties. The following sections provide recommendations for seismic design considerations, foundation design, permanent building walls, floor slabs, drainage, pavements, and other pertinent geotechnical design and construction issues.

Seismic Hazards

Based on our observation and the subsurface units mapped at the site, we interpret the structural site conditions to correspond to a seismic Site Class “C” in accordance with 2012 IBC (International Building Code) documents. This is based on the likely range of equivalent SPT (Standard Penetration Test) blow counts for the soil types observed in the site area. These conditions were assumed to be representative for the conditions based on our experience in the vicinity of the site.

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure. The increase in pore water pressure is induced by seismic vibrations. Liquefaction mainly affects geologically recent deposits of loose, fine-grained sands that are below the groundwater table. Based on the density of the soil and lack of groundwater, it is our opinion that the risk for liquefaction to occur at this site during an earthquake is negligible.

Recommended Setback

The Mercer Island building department will require setbacks from slopes steeper than 3H:1V (Horizontal:Vertical) to satisfy requirements of the International Building Code (IBC) Section 1805. The typical IBC setback from the top of the slope equals one third the height of the slope, unless evaluated and reduced, and/or a “structural setback” is provided by a licensed geotechnical engineer. Given the height (about 24 feet) and steepness (greater than 30 percent) slopes below the proposed garage, the prescriptive setback would need to be about 8 feet for the downhill side of the structure and 20 feet for the uphill side of the garage.

As currently proposed, the garage will be constructed on the steep slope. Since the setback distance cannot be met, the foundation elements of the structure could be extended vertically to meet the horizontal setback distance. Where the foundation is extended vertically, we recommend that the setback be measured horizontally from the lower outside edge of the foundation element to the face of the slope, as shown on Figure 5. This setback could be met with pin piles or drilled piers, or a deepened foundation.

No fill material should be placed within the setback area unless retained by an engineered structure approved by the geotechnical engineer. No drainage or discharge of roof or driveway runoff should occur within the setback area; however, the use of septic systems within the setback is feasible. If automatic landscaping sprinkler system is utilized, we recommend that the system include an automatic shut off in the event of a sudden pressure drop (pipe rupture or malfunction).

Site Preparation and Grading

All structural areas on the site to be graded should be stripped of vegetation, organic surface soils, and other deleterious materials. Based on the conditions encountered in our boring and hand borings, we anticipate a stripping depth of about 4 to 12 inches.

Where placement of fill material is required, the stripped/exposed subgrade areas should be compacted to a firm and unyielding surface prior to placement of any fill. Excavations for debris removal should be backfilled with structural fill compacted to the densities described in the **"Structural Fill"** section of this report.

The exposed subgrade soil should be proof-rolled with heavy rubber-tired equipment during dry weather or probed with a 1/2-inch-diameter steel rod during wet weather conditions. Any soft, loose or otherwise unsuitable areas delineated during proof-rolling or probing should be re-compacted, if practical, or over-excavated and replaced with structural fill.

Structural Fill

All fill material/trench backfill should be placed as structural fill. The structural fill should be placed in horizontal lifts of appropriate thickness to allow adequate and uniform compaction of each lift. Fill should be compacted to at least 95 percent of MDD (maximum dry density as determined in accordance with ASTM D-1557).

The appropriate lift thickness will depend on the fill characteristics and compaction equipment used. We recommend that the appropriate lift thickness be evaluated by our field representative during construction. We recommend that our representative be present during site grading activities to observe the work and perform field density tests.

The suitability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines (material passing No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. During wet weather, we recommend use of well-graded sand and gravel with less than 5 percent (by weight) passing the No. 200 sieve based on that fraction passing the 3/4-inch sieve. If prolonged dry weather prevails during the earthwork and foundation installation phase of construction, a somewhat higher (up to 10 to 12 percent) fines content will be acceptable.

Material placed for structural fill should be free of debris, significant organic matter, trash and large cobbles/boulders. We recommend that cobbles/boulders between 6 and 24 inches in diameter be removed from the upper 2 feet of fill.

Suitability of On-Site Materials as Fill

The native fine sand to fine sandy silt has an extremely high fines content and will be difficult to impossible to place during periods of heavy precipitation or during periods the wet winter months. These soils could be suitable during the drier summer months or if they can be aerated or dried back.

The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly more sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve. If fill material is imported to the site, we recommend that it be a sand and gravel mixture comparable to the native material or a high quality pit run with less than 5 percent fines.

Temporary Excavations

All job site safety issues and precautions are the responsibility of the contractor providing services/work. The following cut/fill slope guidelines are provided for planning purposes only. Temporary cut slopes will likely be necessary during grading operations or utility installation.

All excavations at the site associated with confined spaces, such as utility trenches and retaining walls, must be completed in accordance with local, state, or federal requirements. Based on current Washington Industrial Safety and Health Act (WISHA, WAC 296-155-66401) regulations, the upper soils on the site would be classified as Type C soils. The deep silty fine sand/fine sandy silt would be classified as Type B soils.

According to WISHA, for temporary excavations of less than 20 feet in depth, the side slopes in Type A soils should be laid back at a slope inclination of ¾H:1V (Horizontal: Vertical) and Type B soils should be laid back at a slope inclination of 1H:1V or flatter from the toe to the crest of the slope. This is only slightly steeper than current slope inclinations.

It should be recognized that slopes of this nature do ravel and require occasional maintenance. All exposed slope faces should be covered with a durable reinforced plastic membrane, jute matting, or other erosion control mats during construction to prevent slope raveling and rutting during periods of precipitation. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant raveling or seepage occurs, or if construction materials will be stockpiled along the slope crest.

Where it is not feasible to slope the site soils back at these inclinations, a retaining structure should be considered. Where retaining structures are greater than 4-feet in height (bottom of footing to top of structure) or have slopes of greater than 15 percent above them, they should be engineered.

This information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that GeoResources assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

Foundation Support

Based on the subsurface soil conditions encountered in our explorations, we recommend that spread footings for the garage be founded on the medium dense to dense near surface native soils, or on appropriately prepared structural fill that extends to suitable native soils. The soil at the base of the footing excavations should be disturbed as little as possible. All loose, soft or unsuitable material should be removed or recompacted, as appropriate.

We recommend a minimum width of 24 inches for isolated footings and at least 12 inches for single story or 16 inches multi-story structures for continuous wall footings. All footing elements should be embedded at least 18 inches below grade for frost protection. Footings founded as described above can be designed using an allowable soil bearing capacity of 2,500 psf (pounds per square foot) for combined dead and long-term live loads. The weight of the footing and any overlying backfill may be neglected. The allowable bearing value may be increased by one-third for transient loads such as those induced by seismic events or wind loads.

Lateral loads may be resisted by friction on the base of footings and floor slabs and as passive pressure on the sides of footings. We recommend that an allowable coefficient of friction of 0.30 be used to calculate friction between the concrete and the underlying soil. Passive pressure may be determined using an allowable equivalent fluid density of 300 pcf (pounds per cubic foot). Factors of safety have been applied to these values.

We estimate that settlements of footings designed and constructed as recommended will be less than ½ inch, for the anticipated load conditions, with differential settlements between comparably loaded footings approach total settlements. Most of the settlements should occur essentially as loads are being applied. However, disturbance of the foundation subgrade during construction could result in larger settlements than predicted. We recommend that all foundations be provided with footing drains.

Alternative Foundation Design

Because of site slope below the garage and required loads, it may be necessary to go pile support the structure. We provided recommendation for small diameter drive pin piles below, and can provide recommendations for auger cast piles, drilled shafts, or other deep pile foundations, if requested.

Alternate Foundation Support – Pin Piles

In order to meet IBC setback requirements, it may be necessary to use small diameter driven pipe piles. It is our opinion this system could consist of small diameter pin piles. Pin piling consist of small diameter Schedule-80 steel pipe that are driven into the underlying soils to refusal. Schedule 80 steel is used instead of schedule 40 for corrosion resistance. The steel pipe diameters range from 2 to 6-inches. Individual pipe segments typically range from about 5 to 21 feet long and are successively joined with external threaded couplings, internal slip couplings, or butt welds as pile driving progresses.

Regardless of diameter or installation method, in order to achieve design loads, each pin pile be driven to a point of refusal during sustained driving. However, for setback criteria, piles will need to have a minimum embedment depth of 8 to 20 feet, as described above in the **Setback** section of this report.

Because refusal depths are difficult to predict and because soil conditions could vary significantly across the site, we recommend a test pile be installed. The contractor should be prepared for variable pile lengths. Also, it may be necessary to modify pile layouts if rocks or other obstructions are encountered during pile-driving.

When refusal has been achieved, the pin piles can be cut to a predetermined height or elevation. To provide a good bond between the piles and the pile cap, reinforcing bars with 90-degree bends can be welded to the top of the pile or, alternatively, the top of the pile can be splayed apart. A structural engineer should be responsible for designing the reinforced steel and foundation elements. The minimum pile spacing (center to center) shall be determined by the structural engineer. Piles larger than 2 inches in diameter should be tested in accordance with the ASTM quick test method.

In our opinion, properly installed pin piling driven to refusal (as defined above) will provide the following allowable axial capacities.

Design Parameter	Allowable Value 2-inch-diameter	4-inch-diameter	6-inch-diameter
Static Compressive Capacity	4,000 pounds	20,000 pounds	30,000 pounds
Transient Compressive Capacity	5,300 pounds	26,000 pounds	39,000 pounds

Floor Slab Support

The garage floor will either consist of a slab-on-grade floors supported by structural fill, or by a structural slab spanning an open crawl space. If a slab-on-grade floor is used, it should be supported on structural fill prepared as described above.

We recommend that floor slabs be directly underlain by a minimum 4-inch thickness capillary break material such as pea gravel, or clean crushed rock with less than 2 percent fines. The capillary break material should be placed in one lift and compacted to an unyielding condition.

A synthetic vapor barrier is recommended to control moisture migration through the slabs. This is of particular importance where the foundation elements are underlain by the silty till, or where moisture migration through the slab is an issue, such as where adhesives are used to anchor carpet or tile to the slab.

Subgrade Retaining Walls

The lateral pressures acting on subgrade (basement) walls will depend upon the nature and density of the soil behind the wall. It is also dependent upon the presence or absence of hydrostatic pressure. If the walls are backfilled with granular well-drained soil, the design active pressure may be taken as 35 pcf (equivalent fluid density). This design value assumes a level backslope and drained conditions as described below. The design for active pressure assumes the walls can yield 0.001 times the wall height. We can provide site specific lateral earth pressures if the structural engineering determines that the walls will be restrained from movement by diaphragms or floors.

Positive drainage, which controls the development of hydrostatic pressure, can be accomplished by placing a zone of coarse sand and gravel behind the walls. The granular drainage material should contain less than 5 percent fines. The drainage zone should extend horizontally at least 18 inches from the back of the wall. The drainage zone should also extend from the base of the wall to within 1-foot of the top of the wall. The drainage zone should be compacted to approximately 90 percent of the MDD. Over-compaction should be avoided as this can lead to excessive lateral pressures.

A perforated PVC pipe with a minimum diameter of 4 inches should be placed in the drainage zone along the base of the wall to direct accumulated water to an appropriate discharge location. We recommend that a nonwoven geotextile filter fabric be placed between the drainage material and the remaining wall backfill to reduce silt migration into the drainage zone. The infiltration of silt into the drainage zone can, with time, reduce the permeability of the granular material. The filter fabric should be placed such that it fully separates the drainage material and the backfill, and should be extended over the top of the drainage zone.

Lateral loads may be resisted by friction on the base of footings and as passive pressure on the sides of footings and the buried portion of the wall. We recommend that an allowable coefficient of friction of 0.30 be used to calculate friction between the concrete and the underlying soil. Passive pressure may be determined using an allowable equivalent fluid density of 300 pcf (pounds per cubic foot). Factors of safety have been applied to these values.

Wet Weather and Wet Condition Considerations

In the Puget Sound area, wet weather generally begins about mid-October and continues through about May, although rainy periods could occur at any time of year. Therefore, it would be advisable to schedule earthwork during the dry weather months of June through September. Most of the soil at the site contains sufficient fines to produce an unstable mixture when wet. Such soil is highly susceptible to changes in water content and tends to become unstable and difficult or impossible to proof-roll and compact if the moisture content exceeds the optimum.

In addition, during wet weather months, shallow perched groundwater may develop, resulting in seepage into site excavations. Performing earthwork during dry weather would reduce these problems and costs associated with rainwater, construction traffic, and handling of wet soil. However, should wet weather/wet condition earthwork be unavoidable, the following recommendations are provided:

- The ground surface in and surrounding the construction area should be sloped as much as possible to promote runoff of precipitation away from work areas and to prevent ponding of water.
- Work areas or slopes should be covered with plastic. The use of sloping, ditching, sumps, dewatering, and other measures should be employed as necessary to permit proper completion of the work.
- Earthwork should be accomplished in small sections to minimize exposure to wet conditions. That is, each section should be small enough so that the removal of unsuitable soils and placement and compaction of clean structural fill could be accomplished on the same day. The size of construction equipment may have to be limited to prevent soil disturbance. It may be necessary to excavate soils with a backhoe, or equivalent, and locate them so that equipment does not pass over the excavated area. Thus, subgrade disturbance caused by equipment traffic would be minimized.
- Fill material should consist of clean, well-graded, sand and gravel, of which not more than 5 percent fines by dry weight passes the No. 200 mesh sieve, based on wet sieve's the fraction passing the ¾-inch mesh sieve. The gravel content should range from between 20 and 50 percent retained on a No. 4 mesh sieve. The fines should be non-plastic.
- No exposed soil should be left un-compacted and exposed to moisture. A smooth-drum vibratory roller, or equivalent, should roll the surface to seal out as much water as possible.
- In-place soil or fill soil that becomes wet and unstable and/or too wet to suitably compact should be removed and replaced with clean, granular soil (see gradation requirements above in the **Structural Fill** section of this report).
- Excavation and placement of structural fill material should be observed on a full-time basis by a geotechnical engineer (or representative) experienced in wet weather/wet condition earthwork to determine that all work is being accomplished in accordance with the project specifications and our recommendations.
- Grading and earthwork should not be accomplished during periods of heavy, continuous rainfall.

We recommend that the above requirements for wet weather/wet condition earthwork be incorporated into the contract specifications.

Erosion Control

Weathering, erosion and the resulting surficial sloughing and shallow land sliding are natural processes that affect steep slope areas. As noted, no evidence of surficial raveling or sloughing was observed at the site. To manage and reduce the potential for these natural processes, we recommend the following:

- No drainage of concentrated surface water or significant sheet flow onto or near the steep slope area.
- No additional fill should be placed within the setback area.
- Grading should be limited to providing surface grades that promote surface flows away from the top of slope to an appropriate discharge location beyond the toe of the slope, such as into Puget Sound.

We recommend that the lot above the slope be graded so that no overbank concentrated flows can occur. This may entail the placement of a small berm at the crest of the slope to divert and collect any storm flows away from the steepest portion of bank.

LIMITATIONS

We have prepared this report for Mr. Mike Boyle, Fat Boy Construction, and other design team members for use in evaluating a portion of this project. The data used in preparing this report and this report should be provided to prospective contractors for their bidding or estimating purposes only. Our report, conclusions and interpretations are based on data from others and limited site reconnaissance and should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations and may also occur with time. A contingency for unanticipated conditions should be included in the budget and schedule. Sufficient monitoring, testing and consultation should be provided by our firm during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and foundation installation activities comply with contract plans and specifications.

The scope of our services does not include services related to environmental remediation and construction safety precautions. 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.

If there are any changes in the loads, grades, locations, configurations or type of facilities to be constructed, the conclusions and recommendations presented in this report may not be fully applicable. If such changes are made, we should be given the opportunity to review our recommendations and provide written modifications or verifications, as appropriate.

◆ ◆ ◆

We have appreciated working for you on this project. Please do not hesitate to call at your earliest convenience if you have any questions or comments.

Yours very truly,
GeoResources, LLC

State of Washington
Engineering Geologist
925
Licensed Geologist
KEITH SCOTT SCHEMBS
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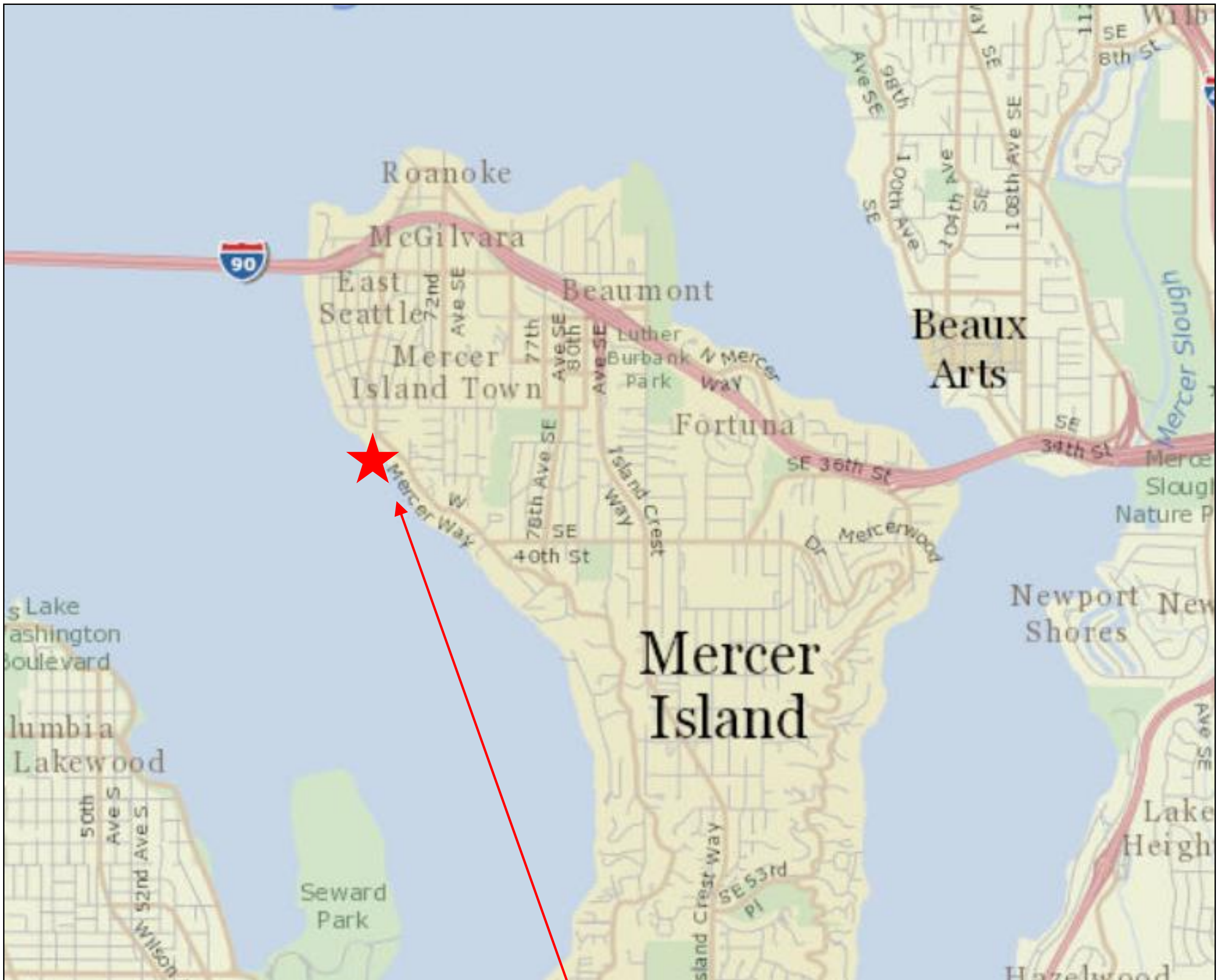
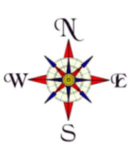
Doc.ID FatBoyCon.WMercerWay.RGr.doc
Attachments: Figure 1 – Site Location Map
Figure 2 – Conceptual Plan
Figure 3 – Site and Exploration Plan
Figure 4 – NRCS Soils Survey Map
Figure 5 – USGS Geologic Survey Map
Figure 6 – Structural Setback
Appendix A – Subsurface Explorations
Appendix B – Laboratory Test Results
Appendix C – Slope Stability Analysis



Approximate Site Location
(map created from King County iMap http://gismaps.kingcounty.gov/iMap/)



Not to Scale

GeoResources, LLC 5007 Pacific Highway East, Suite 16 Fife, Washington 98424 Phone: 253-896-1011 Fax: 253-896-2633	**Site Location Map** Proposed Detached Garage 3603 W Mercer Way Mercer Island, Washington		
	Job: FatBoyConstruction.WMercerWay.F	**November 2015**	**Figure 1**

Not to Scale

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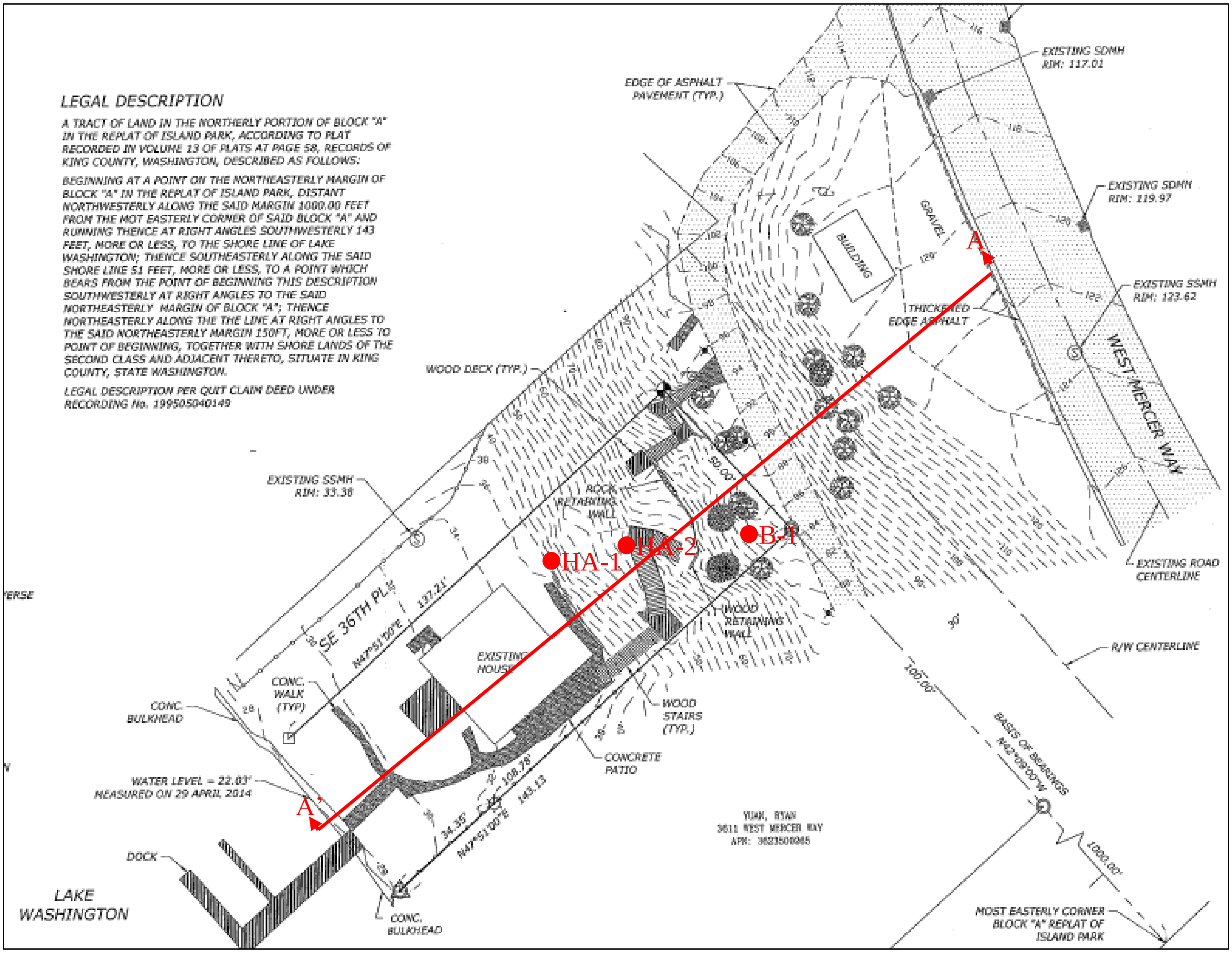
Conceptual Plan
Proposed Detached Garage
3603 W Mercer Way
Mercer Island, Washington

Job: FatBoyConstruction.WMercerWay.F	November 2015	Figure 2



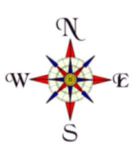
Approximate Site Location

(site plan by Beyler Consulting,9/11/2014)

Not to Scale

●B-1 Approximate location and number of boring

Geologic Cross Section



Not to Scale

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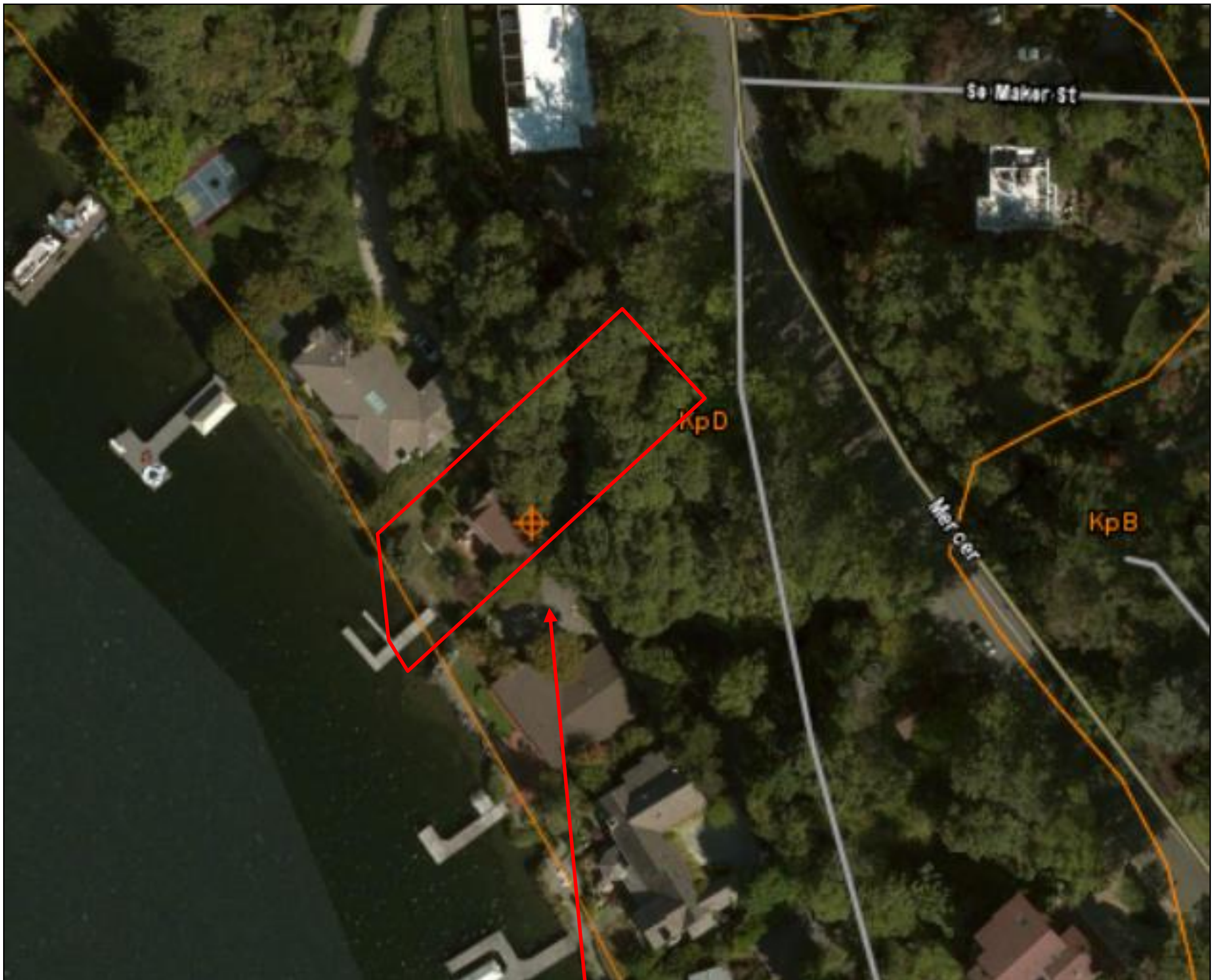
Fife, Washington 98424
Phone: 253-896-1011
Fax: 253-896-2633

Site and Exploration Plan

Proposed Detached Garage
3603 W Mercer Way
Mercer Island, Washington

Job: FatBoyConstruction.WMercerWay.F	November 2015	Figure 3



Approximate Site Location

(map created from the USDA Natural Resource Conservation Service Web Soil Survey)

Soil Type	Soil Name	Parent Material	Slopes	Erosion Hazard	Hydrologic Soils Group
KpD	Kitsap Silt Loam	Glacial Lake Sediments	16 – 30	Moderate to Severe	C

N W E S

Not to Scale

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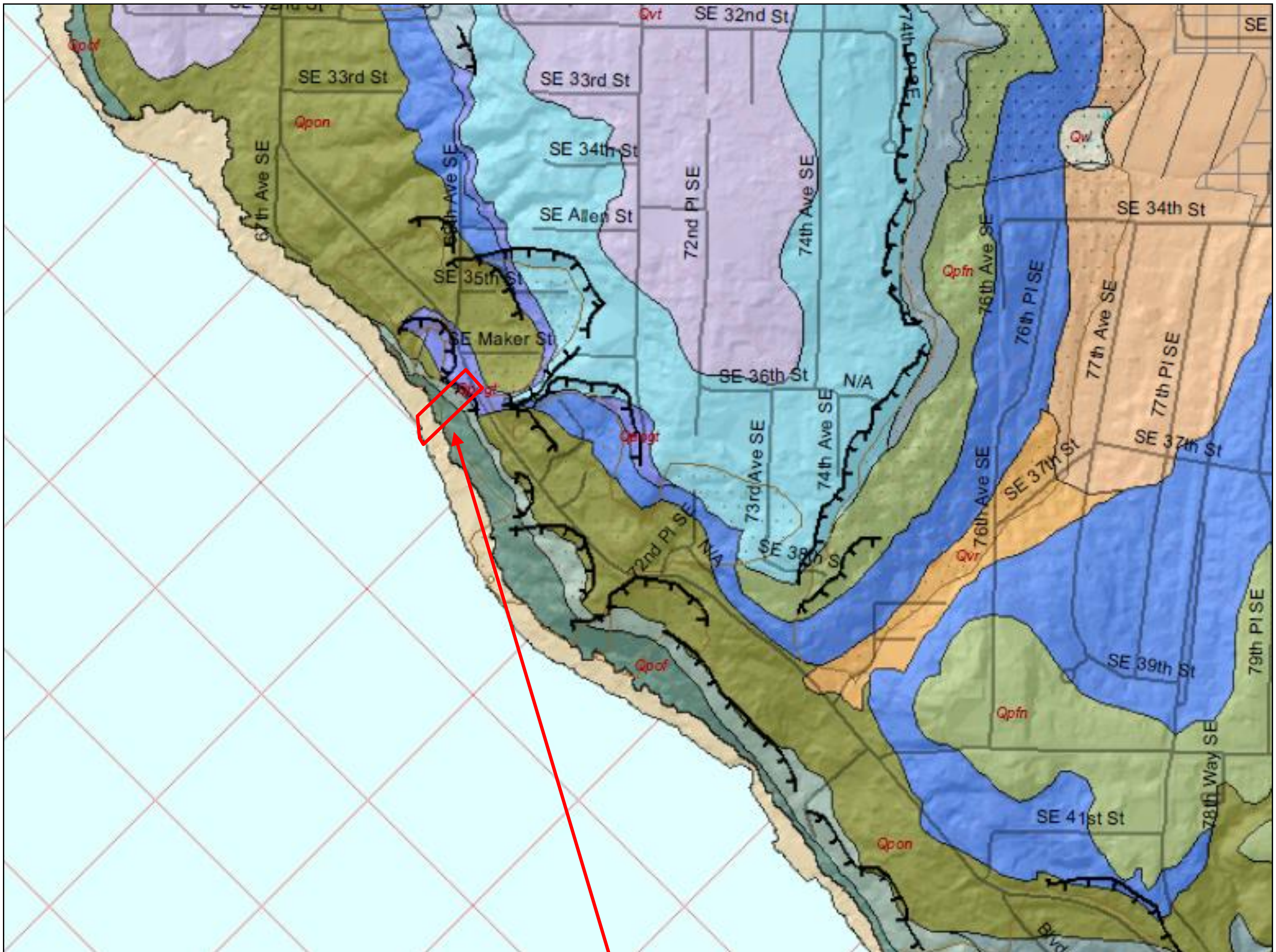
NRCS SCS Soils Map
Proposed Detached Garage
3603 W Mercer Way
Mercer Island, Washington

Job: FatBoyConstruction.WMercerWay.F	November 2015	Figure 4



Approximate Site Location

Excerpt from the *Geologic Map of Mercer Island, Washington* by Kathy G. Troost and Aaron P. Wisher (October 2006)

	Qpogt	Pre-Olympia Glacial Till Deposits
	Qpon	Pre-Olympia Non-Glacial Deposits
	Qpoc	Pre-Olympia Coarse Grained Deposits
	Qpof	Pre-Olympia Fine Grained Deposits
	Ql	Lake Deposits

N W E S

Not to Scale

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USGS Geologic Map
Proposed Detached Garage
3603 W Mercer Way
Mercer Island, Washington

Job: FatBoyConstruction.WMercerWay.F	November 2015	Figure 5

Appendix "A"

Subsurface Explorations

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More than 50% Retained on No. 200 Sieve	GRAVEL More than 50% Of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More than 50% Of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or more	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Description of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and or test data.

SOIL MOISTURE MODIFIERS:

Dry- Absence of moisture, dry to the touch

Moist- Damp, but no visible water

Wet- Visible free water or saturated, usually soil is obtained from below water table

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Unified Soil Classification System
Proposed Detached Garage
3603 W Mercer Way
Mercer Island, Washington

Job: FatBoyConstruction.WMercerWay.F | **November 2015** | **Figure A-1**

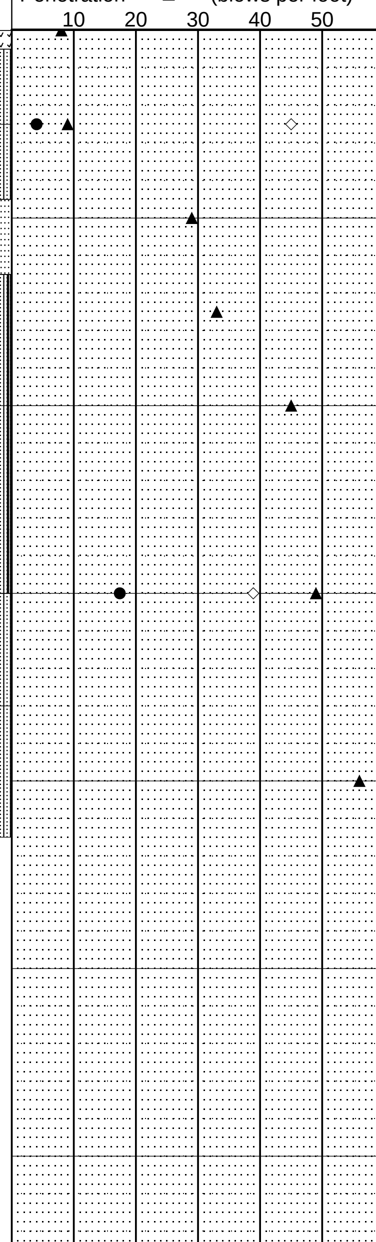
TOTAL DEPTH:	21.5	**DRILLING METHOD:**	HSA	**LOGGED BY:**	KSS
TOP ELEVATION:		**DRILLING COMPANY:**	CN Drilling	**HAMMER TYPE:**	Cathead
LATITUDE:		**DRILL RIG:**	Acker	**HAMMER WEIGHT:**	140lbs
LONGITUDE:		**NOTES:**			

Depth	Elevation	SOIL DESCRIPTION	DRILLING NOTES	Sample	Blow Count	Ground Water
0		Topsoil/Duff				
		Tan/gray fine SAND with some silt (loose, moist)		1	1 2 6	
		silty sand grades to		2	1 4 5	
5		Dark gray fine to medium SAND (medium dense, moist)		3	9 14 15	
		Grades to blue-gray fine sandy SILT (very stiff, moist)		4	5 12 21	
10		Becomes interbedded gray fine sand and silt (dense, moist)		5	11 19 26	
15		silty sand grades to		6	12 22 27	
		Gray silty fine to medium SAND (dense, moist)		7		
20				8	14 24 32	
		Bottom of Boring CompletedNov 3, 2015				
25						
30						

TEST RESULTS

Plastic Limit ├──┤ Liquid Limit
% Water Content ●
% Fines (<0.075mm) ◇

Penetration - ▲ (blows per foot)



NOTES
1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered
5. ATD = At the Time of Drilling

Proposed SFR
3603 W Mercer Way
Mercer Island, WA

LOG OF BORING B-1

JOB: Boyle.WMercerWay

Sheet 1 of 1

GeoResources, LLC

FIG.A-2

Hand Auger HA-1

Location: South of Proposed Single-Family Home
Approximate Elevation: 38 feet

Depth (feet)			Soil Type	Soil Description
0.0	-	1.0		Brown silty SAND with organics (medium dense, moist)
1.0	-	2.0	SP	Grey silty SAND with mottling, wood debris, and organics (medium dense, moist)
2.0	-	3.5	SP	Brown SAND with silt, mottling, and wood debris (medium dense, moist)
3.5	-	4.3	CL	Grey fine sandy SILT with mottling (medium dense, moist)
4.3	-	4.5	SP	Grey SAND with silt to silty fine SAND (dense, moist)
4.5	-	5.0	SP	Grey SAND with silt to silty fine SAND (dense, wet)
5.0	-	5.5	CL	Grey SILTwith some fine sandy (dense, wet)

Terminated at 5.5 feet below ground surface.
No caving observed.
Groundwater observed at 5 feet below ground surface.

Hand Auger HA-2

Location: Southwest of Proposed Single-Family Home
Approximate Elevation: 62 feet

Depth (feet)			Soil Type	Soil Description
0.0	-	0.3		Topsoil, duff
0.3	-	1.0	SP	Light brown SAND with organics and roots (medium dense)
1.0	-	1.6	SP	Light brown SAND with mottling (medium dense)
1.6	-	3.5		Grey SAND with mottling (medium dense)
3.5	-	4.0	SP	Grey SAND with wood debris (medium dense)
4.0	-	6.0	SP	Grey/tan fine SAND (dense)

Terminated at 6.0 feet below ground surface.
No caving observed.
No groundwater seepage observed.

Logged by: DRT

Excavated on: November 12, 2015

GeoResources, LLC
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Hand Auger Logs
Proposed Detached Garage
3603 W Mercer Way
Mercer Island, Washington

Appendix “B”

Laboratory Test Results

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	54.8	45.0	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.375	100.0		
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.4		
#100	86.6		
#200	45.0		

* (no specification provided)

Material Description

silty sand
NM-4.0%

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= 0.1720 D_{85}= 0.1461 D_{60}= 0.0963
D_{50}= 0.0816 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID: 091511

Date Received: **Date Tested:** 11/4/15
Tested By: JPK
Checked By: KSS
Title: PM

Source of Sample: B-1 **Depth:** 2.5 **Date Sampled:** 11/3/15
Sample Number: 2

GeoResources, LLC

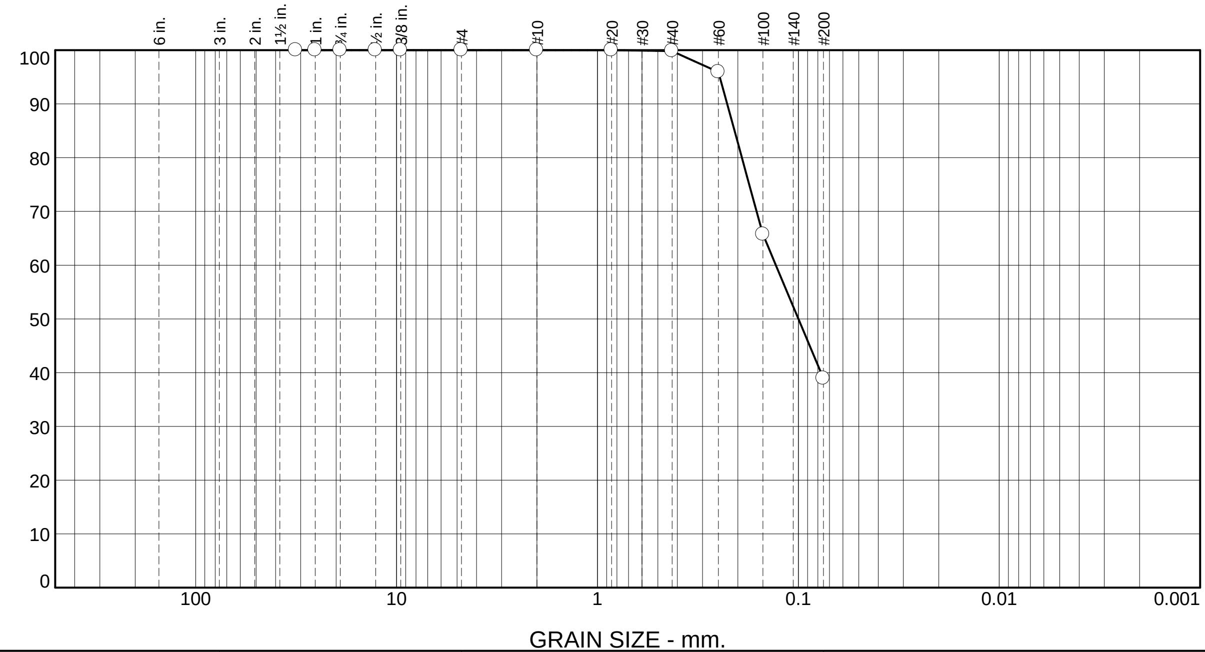
Fife, WA

Client: Mike Boyle c/o Fatboy Construction
Project: Proposed SFR
Project No: Boyle.WMercerWay **Figure** B-1

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: ____________ **Checked By:** ____________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	60.9	38.9	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.375	100.0		
#4	100.0		
#10	100.0		
#20	100.0		
#40	99.8		
#60	95.9		
#100	65.7		
#200	38.9		

* (no specification provided)

Material Description

silty sand
NM- 17.4%

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.2262 D_{85}= 0.2078 D_{60}= 0.1294
D_{50}= 0.0999 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID: 091512

Date Received: **Date Tested:** 11/4/15
Tested By: JPK
Checked By:
Title:

Source of Sample: B-1 **Depth:** 15 **Date Sampled:** 11/3/15
Sample Number: 6

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

GeoResources, LLC

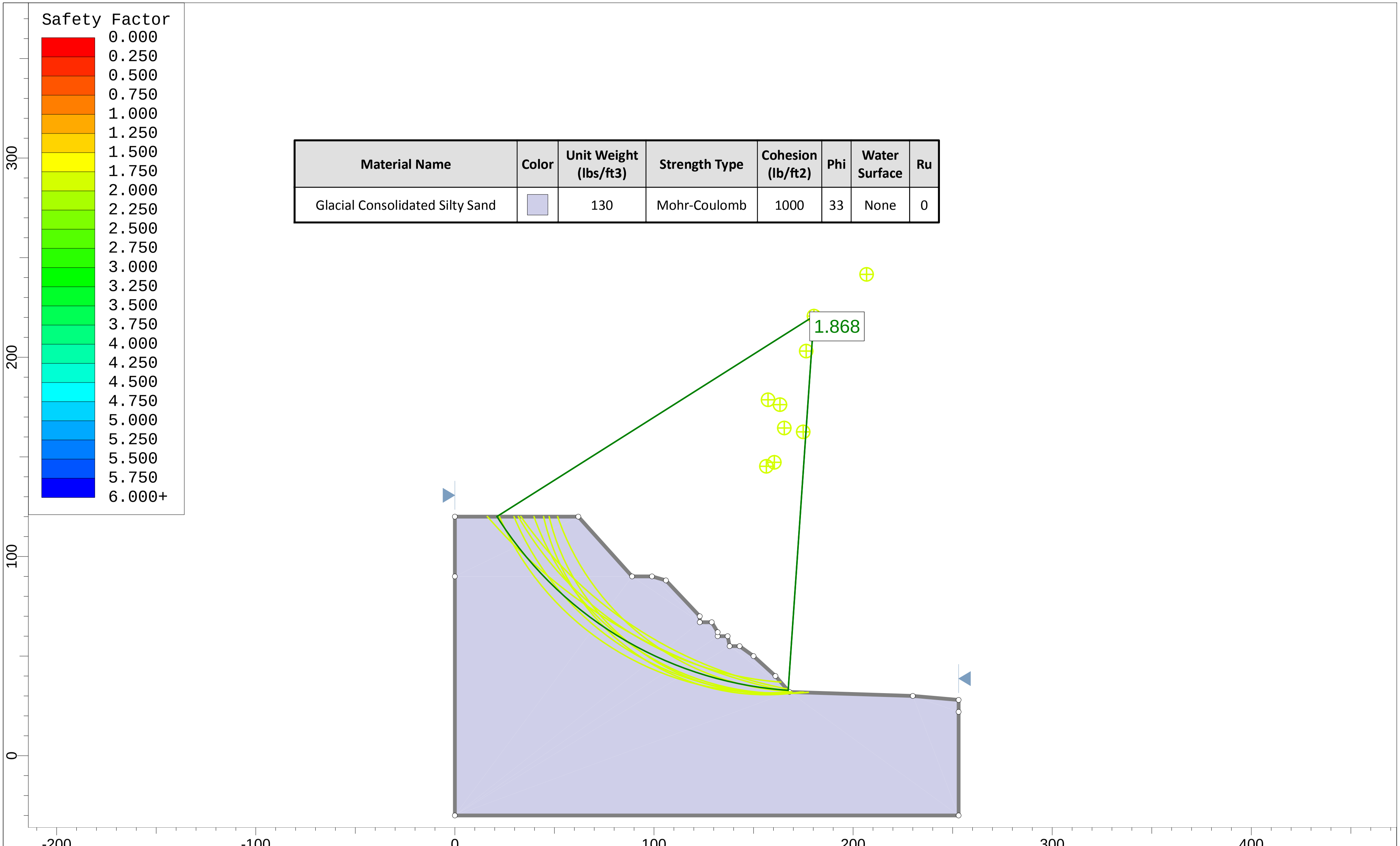
Fife, WA

Client: Mike Boyle c/o Fatboy Construction
Project: Proposed SFR
Project No: Boyle.WMercerWay **Figure** B-2

Tested By: ______________ **Checked By:** ______________

Appendix "C"

Slope Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface	Ru
Glacial Consolidated Silty Sand		130	Mohr-Coulomb	1000	33	None	0

SLIDEINTERPRET 6.009

Project	SLIDE - An Interactive Slope Stability Program
Analysis Description	
Drawn By	
Scale	1:800
Company	
Date	12/28/2015, 2:20:24 PM
File Name	FatBoyCon.WMercerWay.existing.static.slim

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: FatBoyCon.WMercerWay.existing.static
Slide Modeler Version: 6.009
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 12/28/2015, 2:20:24 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: 3

Material Properties

Property	Glacial Consolidated Silty Sand
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	130
Cohesion [psf]	1000
Friction Angle [deg]	33
Water Surface	None
Ru Value	0

Global Minimums

Method: gle/morgenstern-price

FS: 1.868230
Center: 180.337, 220.636
Radius: 188.384
Left Slip Surface Endpoint: 21.086, 120.000
Right Slip Surface Endpoint: 167.389, 32.698
Resisting Moment=9.13331e+007 lb-ft
Driving Moment=4.88875e+007 lb-ft
Resisting Horizontal Force=412223 lb
Driving Horizontal Force=220649 lb

Valid / Invalid Surfaces

Method: gle/morgenstern-price

Number of Valid Surfaces: 4592
Number of Invalid Surfaces: 408

Error Codes:

Error Code -100 reported for 3 surfaces
Error Code -101 reported for 1 surface

Error Code -103 reported for 3 surfaces
Error Code -105 reported for 2 surfaces
Error Code -106 reported for 68 surfaces
Error Code -108 reported for 104 surfaces
Error Code -109 reported for 1 surface
Error Code -111 reported for 78 surfaces
Error Code -115 reported for 148 surfaces

Error Codes

The following errors were encountered during the computation:

-100 = Both surface / slope intersections are on the same horizontal surface. In general, this will give a very high or infinite factor of safety (zero driving force), if calculated.
-101 = Only one (or zero) surface / slope intersections.
-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-105 = More than two surface / slope intersections with no valid slip surface.
-106 = Average slice width is less than 0.0001 * (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-109 = Soiltype for slice base not located. This error should occur very rarely, if at all. It may occur if a very low number of slices is combined with certain soil geometries, such that the midpoint of a slice base is actually outside the soil region,even though the slip surface is wholly within the soil region.
-111 = safety factor equation did not converge
-115 = Surface too shallow, below the minimum depth.

Slice Data

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.86823

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.85212	3314.43	Glacial Consolidated Silty Sand	1000	33	493.638	922.229	-119.757	0	-119.757
2	5.85212	9586.91	Glacial Consolidated Silty Sand	1000	33	763.094	1425.64	655.421	0	655.421
3	5.85212	15213.7	Glacial Consolidated Silty Sand	1000	33	994.248	1857.48	1320.41	0	1320.41
4	5.85212	20308.4	Glacial Consolidated Silty Sand	1000	33	1201.09	2243.91	1915.46	0	1915.46
5	5.85212	24951.9	Glacial Consolidated Silty Sand	1000	33	1393.11	2602.65	2467.86	0	2467.86
6	5.85212	29203.9	Glacial Consolidated Silty Sand	1000	33	1576.87	2945.95	2996.5	0	2996.5
7	5.85212	33110.1	Glacial Consolidated Silty Sand	1000	33	1757.07	3282.61	3514.9	0	3514.9
8	5.85212	34190	Glacial Consolidated Silty Sand	1000	33	1835.67	3429.46	3741.05	0	3741.05

9	5.85212	32558.8	Glacial Consolidated Silty Sand	1000	33	1812.43	3386.03	3674.17	0	3674.17
10	5.85212	30669.9	Glacial Consolidated Silty Sand	1000	33	1783.6	3332.18	3591.25	0	3591.25
11	5.85212	28542.9	Glacial Consolidated Silty Sand	1000	33	1747.58	3264.88	3487.61	0	3487.61
12	5.85212	26579.8	Glacial Consolidated Silty Sand	1000	33	1719.65	3212.71	3407.27	0	3407.27
13	5.85212	28064	Glacial Consolidated Silty Sand	1000	33	1851.32	3458.7	3786.07	0	3786.07
14	5.85212	29956.8	Glacial Consolidated Silty Sand	1000	33	2009.72	3754.62	4241.74	0	4241.74
15	5.85212	30339.3	Glacial Consolidated Silty Sand	1000	33	2099.44	3922.23	4499.85	0	4499.85
16	5.85212	27899.4	Glacial Consolidated Silty Sand	1000	33	2043.24	3817.24	4338.17	0	4338.17
17	5.85212	24840.7	Glacial Consolidated Silty Sand	1000	33	1941.1	3626.43	4044.34	0	4044.34
18	5.85212	21088.5	Glacial Consolidated Silty Sand	1000	33	1783.86	3332.66	3591.98	0	3591.98
19	5.85212	19839.9	Glacial Consolidated Silty Sand	1000	33	1744.98	3260.03	3480.14	0	3480.14
20	5.85212	16507.9	Glacial Consolidated Silty Sand	1000	33	1573.63	2939.91	2987.2	0	2987.2
21	5.85212	14092.2	Glacial Consolidated Silty Sand	1000	33	1437.17	2684.97	2594.64	0	2594.64
22	5.85212	12889.9	Glacial Consolidated Silty Sand	1000	33	1357.16	2535.48	2364.44	0	2364.44
23	5.85212	10031.5	Glacial Consolidated Silty Sand	1000	33	1170.55	2186.85	1827.59	0	1827.59
24	5.85212	6568.01	Glacial Consolidated Silty Sand	1000	33	942.614	1761.02	1171.87	0	1171.87
25	5.85212	2355.81	Glacial Consolidated Silty Sand	1000	33	671.327	1254.19	391.423	0	391.423

Interslice Data

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.86823

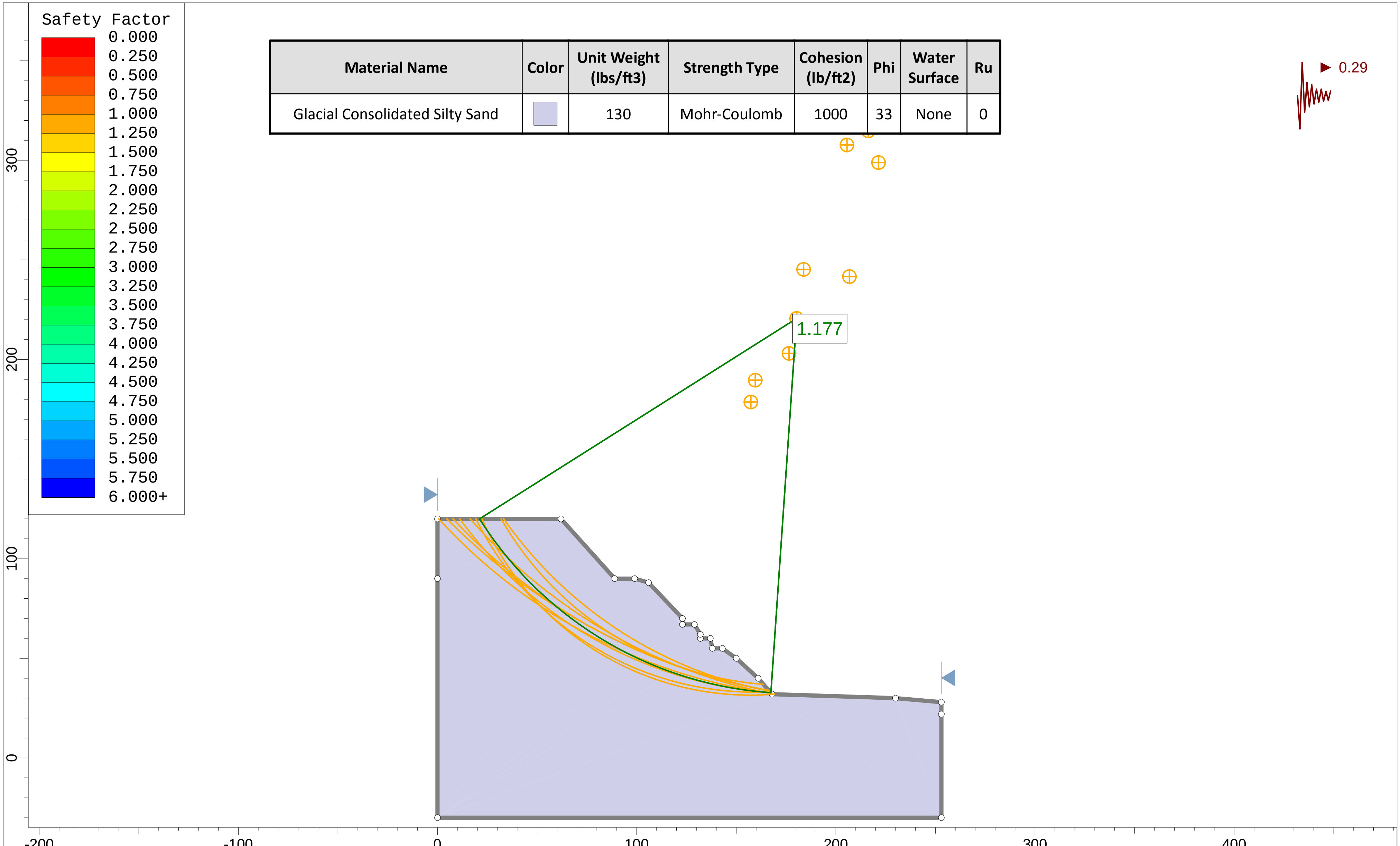
Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	21.0865	120	0	0	0
2	26.9386	111.287	-3927.48	-280.715	4.08824
3	32.7907	103.51	-3288.92	-466.441	8.07197
4	38.6428	96.4945	165.989	34.8464	11.856
5	44.495	90.1167	5365.18	1473.99	15.362
6	50.3471	84.2873	11612.3	3892.44	18.5311
7	56.1992	78.9386	18427.1	7193.57	21.3247
8	62.0513	74.018	25457.2	11186	23.7209

9	67.9034	69.4836	31695.8	15261.5	25.7108
10	73.7555	65.3017	36472	18819.6	27.2938
11	79.6077	61.4444	39903.9	21642.5	28.4739
12	85.4598	57.8887	42094.8	23580.4	29.2564
13	91.3119	54.6152	43201.6	24588.2	29.6464
14	97.164	51.6075	43772.9	24913.3	29.6463
15	103.016	48.8517	43721	24491.4	29.2564
16	108.868	46.3357	42776.8	23200.6	28.4738
17	114.72	44.0494	40757.9	21031.1	27.2938
18	120.572	41.9839	37770.9	18186.7	25.7108
19	126.425	40.1316	34002.2	14940.7	23.7209
20	132.277	38.4861	29534.1	11529.5	21.3246
21	138.129	37.0417	24654.9	8264.31	18.5311
22	143.981	35.7938	19496.2	5356.25	15.362
23	149.833	34.7384	14062.6	2952.2	11.8561
24	155.685	33.8723	8806.82	1249	8.07197
25	161.537	33.1927	4096.05	292.763	4.08823
26	167.389	32.6978	0	0	0

List Of Coordinates

External Boundary

X	Y
0	-30
253	-30
253	22
253	28
230	30
168	32
161	40
150	50
143	55
138	55
137	60
132	60
132	62
129	67
123	67
123	70
106	88
99	90
89	90
62	120
0	120
0	90



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface	Ru
Glacial Consolidated Silty Sand		130	Mohr-Coulomb	1000	33	None	0

Project	FatboyConst.WMercerWay		
Analysis Description	Existing Slope Static Conditions A-A'		
Drawn By	DCB	Scale	1:800
Company	GeoResources, LLC		
Date	12/28/2015, 2:20:24 PM	File Name	FatBoyCon.WMercerWay.existing.Siesmic.slim

SLIDEINTERPRET 6.009

Slide Analysis Information
FatboyConst.WMercerWay

Project Summary

File Name: FatBoyCon.WMercerWay.existing.Siesmic
Slide Modeler Version: 6.009
Project Title: FatboyConst.WMercerWay
Analysis: Existing Slope Static Conditions A-A'
Author: DCB
Company: GeoResources, LLC
Date Created: 12/28/2015, 2:20:24 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: 3

Loading

Seismic Load Coefficient (Horizontal): 0.29

Material Properties

Property	Glacial Consolidated Silty Sand
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	130
Cohesion [psf]	1000
Friction Angle [deg]	33
Water Surface	None
Ru Value	0

Global Minimums

Method: gle/morgenstern-price

FS: 1.176830
Center: 180.337, 220.636
Radius: 188.384
Left Slip Surface Endpoint: 21.086, 120.000
Right Slip Surface Endpoint: 167.389, 32.698
Resisting Moment=8.35416e+007 lb-ft
Driving Moment=7.0989e+007 lb-ft
Resisting Horizontal Force=382843 lb
Driving Horizontal Force=325319 lb

Valid / Invalid Surfaces

Method: gle/morgenstern-price

Number of Valid Surfaces: 4672
Number of Invalid Surfaces: 328

Error Codes:

Error Code -100 reported for 3 surfaces
Error Code -101 reported for 1 surface
Error Code -103 reported for 3 surfaces
Error Code -105 reported for 2 surfaces
Error Code -106 reported for 68 surfaces
Error Code -108 reported for 46 surfaces
Error Code -109 reported for 1 surface
Error Code -111 reported for 56 surfaces
Error Code -115 reported for 148 surfaces

Error Codes

The following errors were encountered during the computation:

-100 = Both surface / slope intersections are on the same horizontal surface. In general, this will give a very high or infinite factor of safety (zero driving force), if calculated.
-101 = Only one (or zero) surface / slope intersections.
-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-105 = More than two surface / slope intersections with no valid slip surface.
-106 = Average slice width is less than 0.0001 * (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-109 = Soiltype for slice base not located. This error should occur very rarely, if at all. It may occur if a very low number of slices is combined with certain soil geometries, such that the midpoint of a slice base is actually outside the soil region,even though the slip surface is wholly within the soil region.
-111 = safety factor equation did not converge
-115 = Surface too shallow, below the minimum depth.

Slice Data

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.17683

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.85212	3314.43	Glacial Consolidated Silty Sand	1000	33	684.372	805.389	-299.675	0	-299.675
2	5.85212	9586.91	Glacial Consolidated Silty Sand	1000	33	1067.02	1255.7	393.747	0	393.747
3	5.85212	15213.7	Glacial Consolidated Silty Sand	1000	33	1352	1591.08	910.182	0	910.182
4	5.85212	20308.4	Glacial Consolidated Silty Sand	1000	33	1574.37	1852.77	1313.16	0	1313.16

5	5.85212	24951.9	Glacial Consolidated Silty Sand	1000	33	1757.34	2068.09	1644.73	0	1644.73
6	5.85212	29203.9	Glacial Consolidated Silty Sand	1000	33	1918.92	2258.24	1937.52	0	1937.52
7	5.85212	33110.1	Glacial Consolidated Silty Sand	1000	33	2074.42	2441.24	2219.32	0	2219.32
8	5.85212	34190	Glacial Consolidated Silty Sand	1000	33	2139.19	2517.46	2336.68	0	2336.68
9	5.85212	32558.8	Glacial Consolidated Silty Sand	1000	33	2127.32	2503.49	2315.18	0	2315.18
10	5.85212	30669.9	Glacial Consolidated Silty Sand	1000	33	2138.08	2516.16	2334.68	0	2334.68
11	5.85212	28542.9	Glacial Consolidated Silty Sand	1000	33	2169.68	2553.35	2391.96	0	2391.96
12	5.85212	26579.8	Glacial Consolidated Silty Sand	1000	33	2235.92	2631.3	2511.99	0	2511.99
13	5.85212	28064	Glacial Consolidated Silty Sand	1000	33	2491.44	2932	2975.02	0	2975.02
14	5.85212	29956.8	Glacial Consolidated Silty Sand	1000	33	2808.71	3305.38	3549.97	0	3549.97
15	5.85212	30339.3	Glacial Consolidated Silty Sand	1000	33	3082.6	3627.7	4046.3	0	4046.3
16	5.85212	27899.4	Glacial Consolidated Silty Sand	1000	33	3201.21	3767.28	4261.25	0	4261.25
17	5.85212	24840.7	Glacial Consolidated Silty Sand	1000	33	3245.01	3818.83	4340.62	0	4340.62
18	5.85212	21088.5	Glacial Consolidated Silty Sand	1000	33	3173.31	3734.45	4210.69	0	4210.69
19	5.85212	19839.9	Glacial Consolidated Silty Sand	1000	33	3200.41	3766.34	4259.78	0	4259.78
20	5.85212	16507.9	Glacial Consolidated Silty Sand	1000	33	2980.56	3507.61	3861.38	0	3861.38
21	5.85212	14092.2	Glacial Consolidated Silty Sand	1000	33	2742.35	3227.28	3429.71	0	3429.71
22	5.85212	12889.9	Glacial Consolidated Silty Sand	1000	33	2536.14	2984.61	3056.04	0	3056.04
23	5.85212	10031.5	Glacial Consolidated Silty Sand	1000	33	2132.84	2509.99	2325.17	0	2325.17
24	5.85212	6568.01	Glacial Consolidated Silty Sand	1000	33	1650.12	1941.91	1450.41	0	1450.41
25	5.85212	2355.81	Glacial Consolidated Silty Sand	1000	33	1106.34	1301.98	465.005	0	465.005

Interslice Data

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.17683

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	21.0865	120	0	0	0

2	26.9386	111.287	-5655.21	-895.331	8.99638
3	32.7907	103.51	-6057.73	-1902.99	17.4397
4	38.6428	96.4945	-3172.66	-1475.32	24.9389
5	44.495	90.1167	1877.9	1142.79	31.3225
6	50.3471	84.2873	8416.97	6249.47	36.5933
7	56.1992	78.9386	16019	13851.9	40.8505
8	62.0513	74.018	24401	23749.6	44.2249
9	67.9034	69.4836	32392	34547.6	46.8444
10	73.7555	65.3017	39065.9	44651.2	48.8169
11	79.6077	61.4444	44452.7	53404	50.2265
12	85.4598	57.8887	48537.3	60225.8	51.1339
13	91.3119	54.6152	51382.8	64778.2	51.5782
14	97.164	51.6075	53888.3	67936.9	51.5782
15	103.016	48.8517	55921.2	69387.9	51.1339
16	108.868	46.3357	56859.2	68308.7	50.2265
17	114.72	44.0494	55957.8	63958	48.8168
18	120.572	41.9839	53135.9	56672	46.8444
19	126.425	40.1316	48479.3	47185.2	44.225
20	132.277	38.4861	42512.3	36761	40.8504
21	138.129	37.0417	35433.3	26308.7	36.5933
22	143.981	35.7938	27750.6	16887.5	31.3224
23	149.833	34.7384	19871.4	9240.42	24.9389
24	155.685	33.8723	12312.2	3867.78	17.4397
25	161.537	33.1927	5545.28	877.928	8.99639
26	167.389	32.6978	0	0	0

List Of Coordinates

External Boundary

X	Y
0	-30
253	-30
253	22
253	28
230	30
168	32
161	40
150	50
143	55
138	55
137	60
132	60
132	62
129	67

123	67
123	70
106	88
99	90
89	90
62	120
0	120
0	90

Appendix “B”

Laboratory Test Results

Appendix "C"

Slope Stability Analysis