3603 W Mercer Way Mercer Island, WA 98040

Drainage Report

Prepared for: **Mike Boyle**
Fatboy Construction
PO Box 44429

May 14th, 2018

Prepared by: **Noah Durr**

Revised by: **Kaycee Doty, EIT**

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Project Number: 17-196
Project Name: Mike Boyle Mercer Way
RPT-Mike Boyle Mercer Way Drainage.docx

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I. Project Engineers Certificate

I hereby certify that this **Drainage Report** for the **3603 W Mercer Way** project has been prepared by me or under my direct supervision and meets minimum standards of care and expertise which is usual and customary in this community for professional engineers. I understand that the **City of Mercer Island** does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me.

03/26/2018

Date

Seal

II. Drainage Report

Section 1 – Project Description

This project proposes to construct a new single family residence with detached garage, associated driveway, and utilities. The proposed development includes associated grading, and landscaping. The subject property's address is 3603 W Mercer Way Mercer Island, King County, WA 98040.

The proposed development of the site will be done using traditional development standards in accordance with the 2014 Stormwater Management Manual for Western Washington (2014 SWMMWW). This report accompanies the drainage plan submittal for the development of this parcel in Mercer Island, WA.

The subject parcel is rectangular in shape approximately 0.16 acres (7,097 sf) in size, 50 feet wide and 143 feet deep, in the zoned R-15 area within the City of Mercer Island. The parcel is currently developed occupied by an existing single-family residence situated on the flatter, lower, western portion of the site. The east side of the parcel sits on a hill with a vertical relief of 60 feet with slopes as great as great as 65-80%. The west side of the parcel is relatively flat with average slopes of 8% and vertical relief of 8 feet. The new house is proposed in the same location as the existing house, on the west side of the property, and the garage will be located at the top of the hill on the east side of the parcel. The proposed garage will utilize the existing access road to the east of the property.

The site is bordered by developed single family properties to north and south. It is bordered by single-family access road to the east and Lake Washington to the west.

At the time of soil exploration by the geotechnical engineer, there is was no evidence of perched seasonal groundwater. However, the geotechnical report states that due to the mapped stratigraphy of the site perched groundwater is anticipated during times of high precipitation. Per Mercer Island's Low Impact Development infiltration feasibility map, infiltration is not permissible on the project site (provided in Appendix D). Further detail can be found in the geotechnical report provided by GeoResources, dated November 3, 2015 located in Appendix D of this report.

Stormwater management for the project site is proposed to consist of collection of stormwater from the proposed roofs and asphalt driveway, and tightlined to the west, where it will be discharged into Lake Washington. The proposed back patio will implement pervious pavers.

As a result of the proposed new/replaced impervious surface a Drainage Report has been prepared per City of Mercer Island's requirements for stormwater permits. The project proposes to mitigate new impervious/replaced impervious surfaces implementing applicable Minimum Requirements #1-5 per Figure 2.4.2 of the 2014 SWMMWW. A copy of Figure 2.4.2 can be found in Appendix C. See below for minimum requirement threshold areas and how each minimum requirement is addressed.

Table 1 Minimum Requirements per Fig 2.4.2 and of 2014 SWMMWW

Threshold Discharge Area (Basin)	Site Area (sf)	New Impervious Surface*(sf)	NEW Impervious Surface*(sf)	Converted Areas to Lawn or Landscape (ac)	Minimum Requirements
1	7,097	2,799 sf	2,799 sf	0.05 ac	#1-5
Threshold		>2,000 sf	>5,000 sf	>0.75 ac	-
Exceeds Threshold?		Yes	No	No	-

Minimum Requirements (per 2015 Manual)

Minimum Requirement #1: Preparation of Stormwater Site Plans.
Requirement met with this drainage report and plan.

Minimum Requirement #2: Construction Stormwater Pollution Prevention Plan (SWPPP)
A CSWPPP has been included in Appendix F addressing Construction SWPPP Elements #1 through #13 as detailed in Volume I, Section 2.5.2 of the 2014 SWMMWW.

Minimum Requirement #3: Source Control of Pollution
Source controls will be utilized on site to prevent stormwater from coming in contact with pollutants.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls
The project proposes to collect all stormwater runoff from roof areas and tightline to a discharge point into Lake Washington. Lake Washington is categorized as a flow control-exempt surface water per Vol. 1 Appendix I-E in the 2014 SWMMWW.

Minimum Requirement #5: On-Site Stormwater Management
Figure 2.5.1 was followed to determine to what extent and what onsite BMPs are necessary. The project triggers Minimum Requirements 1-5. Following Figure 2.3 in Volume I, Section 2.5.1 of the 2014 SWMMWW (Included in Appendix C), projects that trigger Minimum Requirements 1-5, must either meet the LID Performance Standard through the use of any BMP in the Manual, except Rain Gardens or use BMPs from List #1. Since the LID Performance Standard cannot be met, BMP's will be determined using List #1 from the 2014 SWMMWW.

In determining the BMP's for this project, List #1 from the 2014 SWMMWW was applied for "Roofs".

- *Full Dispersion in accordance with BMP T5.30 or Downspout Full Infiltration Systems in accordance with BMP T5.10A. Per the City of Mercer Island Infiltration Feasibility Map (included in Appendix C), the site is not permitted to utilize infiltration.*
- *Bioretention is not feasible due to lack of infiltration. See above.*
- *Downspout Dispersion is infeasible on the project site due to lack of room for the required vegetated flow path length within the setbacks from property lines and structures.*
- *Perforated Stub-out Connection in accordance with BMP T5.10C is feasible and proposed to mitigate the runoff from the proposed roof area.*

"Lawn and Landscaped Areas"

- *Post-Construction Soil Quality and Depth in accordance with BMP T5.13 in Chapter 5 of Volume V.*

"Other Hard Surfaces"

- *Full Dispersion in accordance with BMP T5.30 is not feasible due to lack of room on site for the required vegetated flow path.*
- *Permeable Pavement in accordance with BMP T5.15 is not feasible due to lack of infiltration on the site according the City of Mercer Island Infiltration Feasibility map.*
- *Bioretention BMP's are not feasible for this site due to lack of infiltration.*
- *Sheet Flow dispersion in accordance with BMP T5.12 is infeasible due to lack of room on site for the minimum 25-ft vegetated flow path. The proposed design for the asphalt driveway directs runoff from the driveway to either the proposed trench drain or proposed catch basin. This trench drain and catch basin then route the water through a water-quality catch basin, the catch basin then ties into the perimeter drain which conveys the site's stormwater to the proposed perforated stub-out connection BMP T5.10C.*

Section 2 – Existing Conditions

The subject parcel is rectangular in shape approximately 0.16 acres (7,097 sf) in size, 50 feet wide and 143 feet deep, in the zoned R-15 area within the City of Mercer Island. The parcel is currently developed occupied by an existing single-family residence situated on the flatter, lower, western portion of the site. The east side of the parcel sits on a hill with a vertical relief of 60 feet with slopes as great as great as 65-80%. The west side of the parcel is relatively flat with average slopes of 8% and vertical relief of 8 feet. The new house is proposed in the same location as the existing house, on the west side of the property, and the garage will be located at the top of the hill on the east side of the parcel. The proposed garage will utilize the existing access road to the east of the property.

Section 3 – Soils Investigation/Reports

At the time of soil exploration by the geotechnical engineer, there is was no evidence of perched seasonal groundwater. However, the geotechnical report states that due to the mapped stratigraphy of the site perched groundwater is anticipated during times of high precipitation. Per Mercer Island's Infiltration Feasibility map, infiltration is not permissible on the project site (provided in Appendix D). Further detail can be found in the geotechnical report provided by GeoResources, dated November 3, 2015 located in Appendix D of this report.

An Ordinary High Water Mark was determined by Seweall Wetland Consulting Inc May 1, 2015. The OHWM report is included in Appendix E of this report.

Section 4 – Wells and Septic Systems

Records at King County Water and Land Services were searched for well and septic system records. No records were found for the project site.

Section 5 – Fuel tanks

Records at King County Department of Ecology were searched in order to locate the presence of above and below ground fuel storage tanks that may be located within the setback distances from any stormwater facilities. No fuel tanks were found or identified on the property.

Section 6 – Sub-basin Description

Based on the topography of the area surrounding the project site. There is potential for runoff from uphill to the east to be tributary to the site. A catch basin is proposed and trench drain are proposed in the driveway to collect runoff from the asphalt driveway. The drainage will discharge any stormwater through a tightlined system that daylights out into Lake Washington

In the areas of development, the stormwater management techniques will be installed as to maintain the existing drainage course of the property.

Section 7 – Analysis of 100-year Flood

The Federal Emergency Management Agency prepares maps for all areas within King County, including the incorporated cities therein including Mercer Island. These maps can be found on the FEMA Flood Map service. While a map does exist for the area the project site sits in, FEMA does not offer a finished map. However, Report 53033CV001A states that the City of Mercer Island is considered a non-flood prone community. King County iMAP also does not show the site sitting within 100-year or 500-year flood plain area.

Section 8 – Aesthetic Considerations for Facilities

The stormwater facility for this project will provide little impact on the surrounding aesthetics of the project. This will allow for minimal impact to the existing vegetation.

Section 9 – Facility Sizing

The proposed development for this project will include a new single family residence, new garage, associated driveway, and associated utilities including storm conveyance pipes. To accommodate the developed sub basin area, on-site sheet flow and perforated stub-out connections will be provided for both the driveway and residence. Table 2 below lists out the new impervious areas.

TABLE 2 – New Impervious Area

Surface	Perforated Stub-Out Connections (sf)	Amended Soil (sf)	TOTAL (sf)
Driveway (PGHS)	296	-	296
Single Family	1,311	-	1,311
Garage	695	-	695
Cleared Areas (minus hard surface)	-	4,950	4,950
TOTAL	2,302 sf (0.05 ac)	4,950 sf (0.11 ac)	7,252 sf (0.17 ac)
CREDIT*		Grass	

<u>Rooftop, Perforated Stub-out Connection: BMP T5.10C (Vol.III, S3.1.3)</u>

The rooftop of the new residence will be collected and tightlined to a perforated stub-out connection.

The trench is sized per Volume III, S3.1.3 of the 2014 SWMMWW. Trenches must consist of at least 10-ft of perforated pipe per 5,000 sf of roof area laid in a level, 2-foot wide trench.

Area tributary to trench:
2,302 sf / 5,000 sf = 0.46 x 10 feet = 4.6 feet ≈ 5 feet
However, the minimum length of the trench is 10' per the DOE detail.

A 2'Wx3.9'Dx5'L trench is proposed. See the Drainage Control Plan for trench placement.

Driveway, Perforated Stub-out Connection: BMP T5.10C (Vol.III, S3.1.3)

The proposed design for the asphalt driveway grades it to meet the existing access road. This road sits at a higher elevation than the finished floor of the driveway on the northside, and a lower elevation on the southside. This design required 6" trench drain and a Type-1 CB to collect all the runoff generated by the driveway.

Per the City of Mercer Island Stormwater Requirements, all stormwater runoff from the new driveways must flow through a water quality catch basin per City Standard Detail. Both the trench drain and the batch basin are routed to a water quality catch basin on-site. From this catch basin, the stormwater is routed west where it ties into the perforated stub-out connection system before discharge. See calculations above.

Pipe Conveyance and Discharge

The rational method was implemented to calculate the amount of flow, the proposed impervious surfaces will create.

Q = CIA
Q = peak flow (cfs) for a 100-year storm
C = estimated runoff coefficient (ratio of rainfall that becomes runoff)
I = peak rainfall intensity (in/hr) for a 100-year storm
A = drainage subbasin area (acres)

Area of Garage, Roof, and Driveway: 0.055 ac
C-value = 0.9 for pavement and roof area

I = total precipitation at the project site (P_{100}) multiplied by the unit peak rainfall intensity factor (i_{100}).

- King County Isopluvial maps were referenced to find the total precipitation for a 100-year storm on the project site. P_{100} = 3.9 in
- The 2016 King County Surface Water Design Manual was referenced to calculate the unit peak rainfall intensity factor for the project site. i_{100} = 0.82
- I_{100} = (3.9 in x 0.82) = 3.19 in/hr

Q_{100} = (0.9)(3.19 in/hr)(0.055 ac) = 0.157 cfs

Manning's Equation was implemented to determine if the proposed system has the capacity to handle the flow of runoff calculated.

$$Q = \frac{1.49}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Q = discharge (cfs)
V = velocity (fps)

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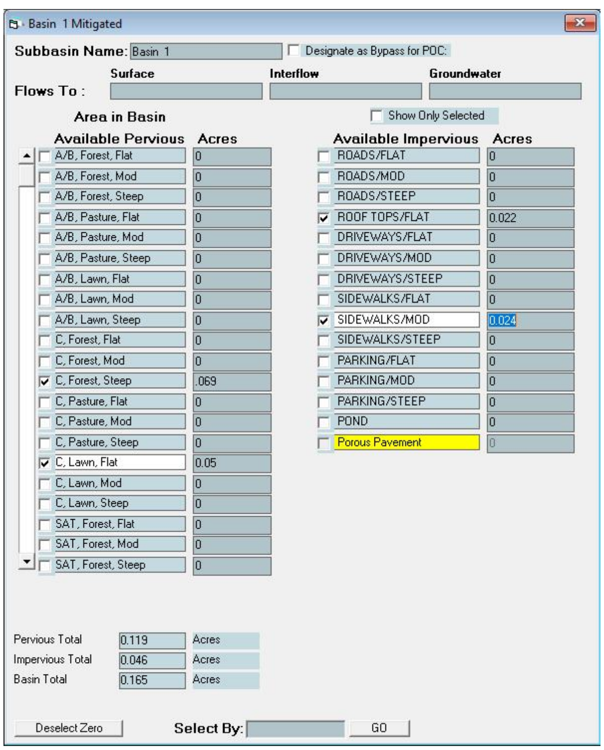
A = area (sf) , A = 0.196 sf
n = manning's roughness coefficient , n= 0.013 for PVC pipe
R = hydraulic radius = area/wetter perimeter (ft)
S = slope of the energy grade line (ft/ft) (min slope of proposed pipe = 2.7%)

$Q = (1.49/0.013)(0.196\ sf)(0.125)^{2/3}(0.025)^{0.5} = 0.924\ cfs > 0.157\ cfs$

From the perforated stub-out connection, the stormwater will flow to the west and discharge into a Lake Washington. Lake Washington is a flow-control exempt water. Design for the outfall protection of the conveyance pipe was designed per Table 4.5.1 (see Appendix C) in the 2014 SWMMWW.

To determine the velocity of the runoff discharging from the perforated stub-out connection. The Circular Channel Ratios chart from ASCE, 1969. Using the ratios of design of the full flow capacity of the conveyance pipe and the calculated flow Q_{100} for this site, the velocity of the runoff from the perforated stub-out connection pipe at the discharge location = 3.53 fps.

Falling under the threshold of 5 fps, Table 4.5.1 requires typical rock lining for outfall protection. The proposed design places the outfall location at the existing boulder bulkhead. The existing structure of the bulkhead satisfies the requires listed in Table 4.5.1 for outfall protection.



Flow Frequency		
Flow(cfs)		0801 15m
2 Year	=	0.0242
5 Year	=	0.0326
10 Year	=	0.0386
25 Year	=	0.0466
50 Year	=	0.0530
100 Year	=	0.0597

Section 10 – Utilities

All utilities will be installed in a manner as not to conflict with any existing utilities. Minimum separations will be maintained for sewer, water, and storm lines during installation.

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Section 11 – Covenants, Dedications, and Easements

All stormwater facilities located on private property shall be owned, operated, and maintained by the property owners, their heirs, successors, and assigns.

Section 12 – Property Owners Association Articles of Incorporation

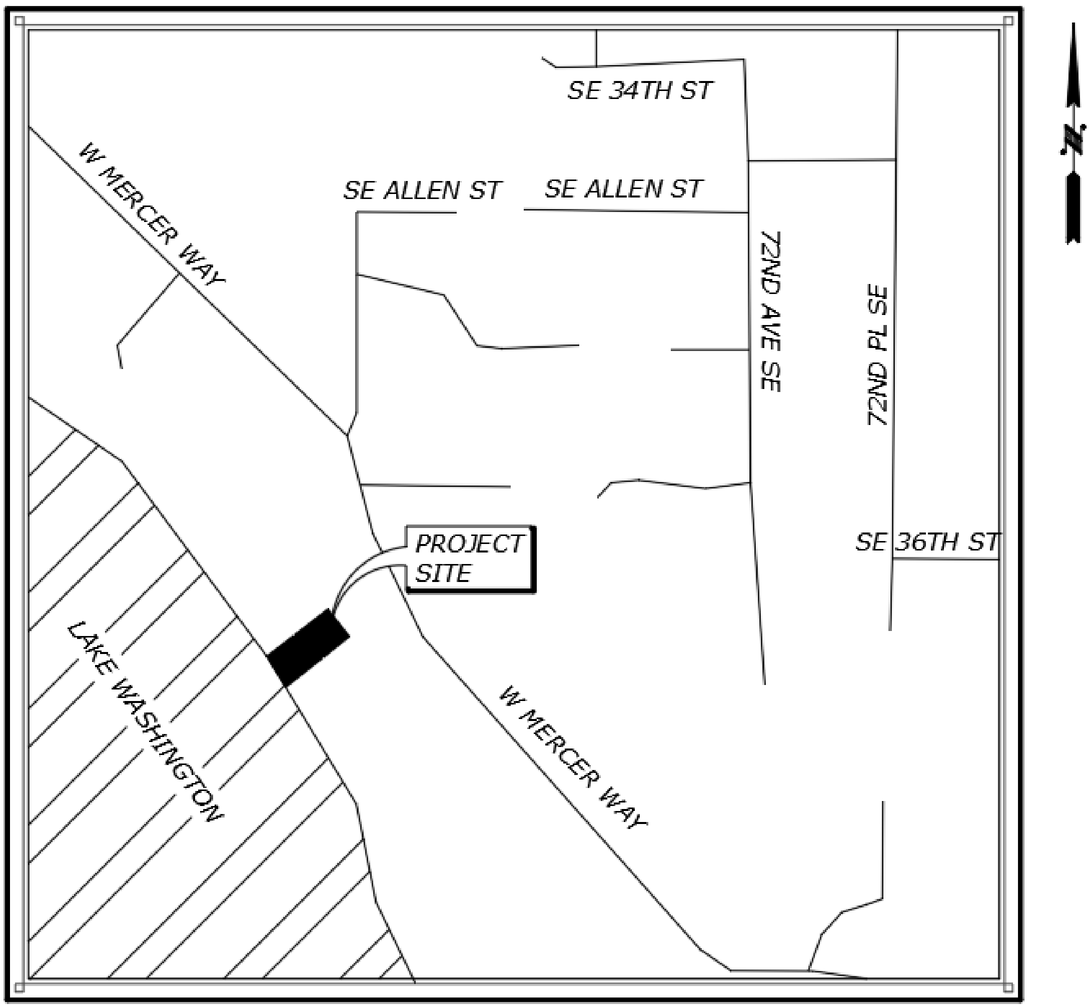
No property owners association is required for this project.

Section 13 – Other Permits or Conditions Placed on the Project

Building Permits will be obtained.

III. Appendices

Appendix A – Vicinity Map



VICINITY MAP

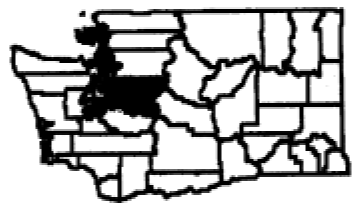
N.T.S

Appendix B – FEMA Report

FLOOD INSURANCE STUDY

KING COUNTY, WASHINGTON

AND INCORPORATED AREAS
VOLUME 1 OF 3



Community Name	Community Number
*ALGONA, CITY OF	530072
AUBURN, CITY OF	530073
*BEAUX ARTS VILLAGE, TOWN OF	530242
BELLEVUE, CITY OF	530074
BLACK DIAMOND, TOWN OF	530272
BOTHELL, CITY OF	530075
BURIEN, CITY OF	530321
CARNATION, CITY OF	530076
*CLYDE HILL, TOWN OF	530279
DES MOINES, CITY OF	530077
DUVAL, TOWN OF	530282
ENUMCLAW, CITY OF	530319
FEDERAL WAY, CITY OF	530322
*HUNTS POINT, TOWN OF	530288
ISSAQUAH, CITY OF	530079
KENT, CITY OF	530080
KIRKLAND, CITY OF	530081
LAKE FOREST PARK, CITY OF	530082
*MEDINA, CITY OF	530315
*MERCER ISLAND, CITY OF	530083
NORMANDY PARK, CITY OF	530084
NORTH BEND, CITY OF	530085
PACIFIC, CITY OF	530086
REDMOND, CITY OF	530087
RENTON, CITY OF	530088
SEATAC, CITY OF	590320
SEATTLE, CITY OF	530089
SKYKOMISH, TOWN OF	530236
SNOQUALMIE, CITY OF	530090
TUKWILA, CITY OF	530091
WOODINVILLE, CITY OF	530324
*YARROW POINT, TOWN OF	530309
KING COUNTY, UNINCORPORATED AREAS	530071

*NON-FLOODPRONE COMMUNITIES

REVISED: APRIL 19, 2005

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
53033CV001A

Appendix C – Other Charts

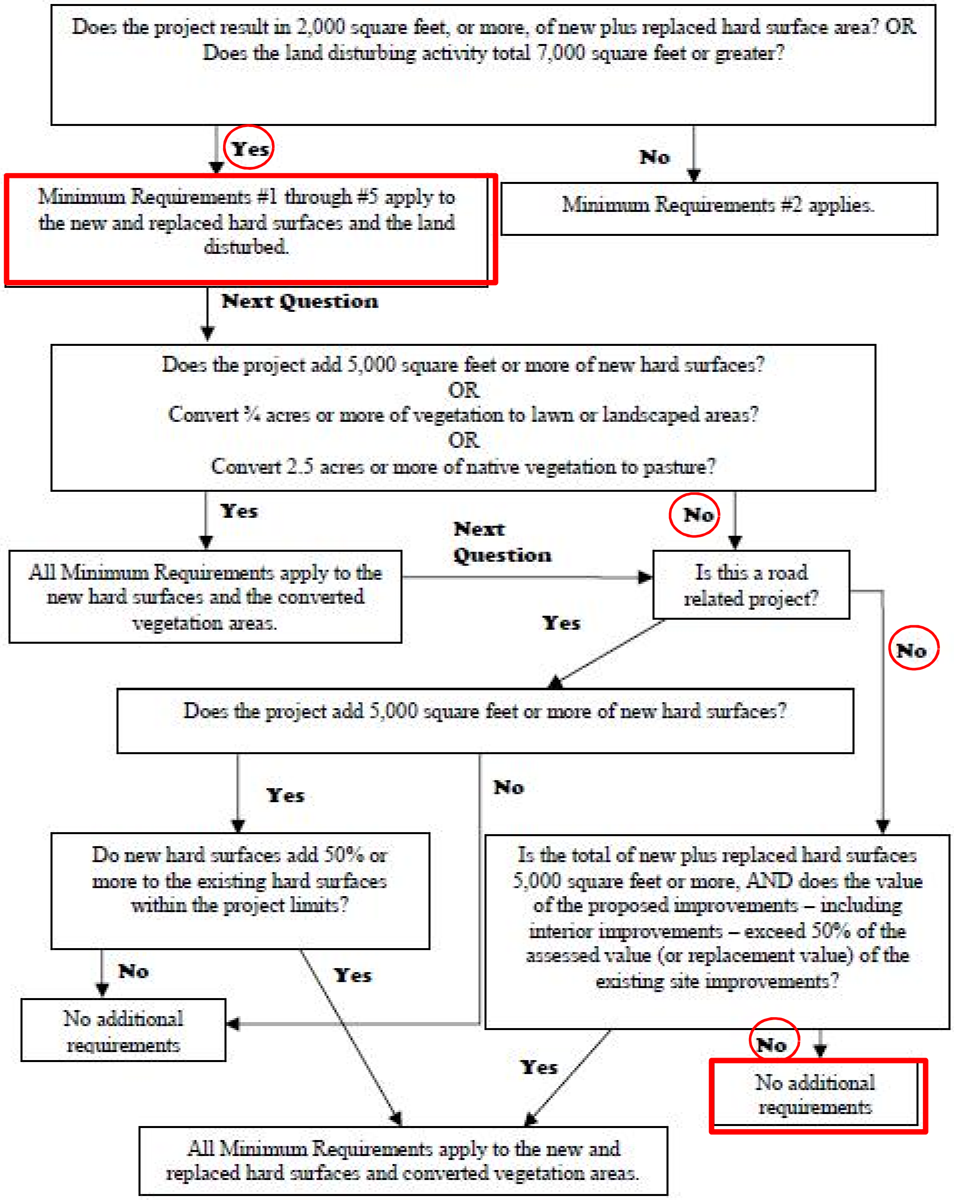


Figure 2.4.2 – Flow Chart for Determining Requirements for Redevelopment

Volume I – Minimum Technical Requirements – December 2014
2-6

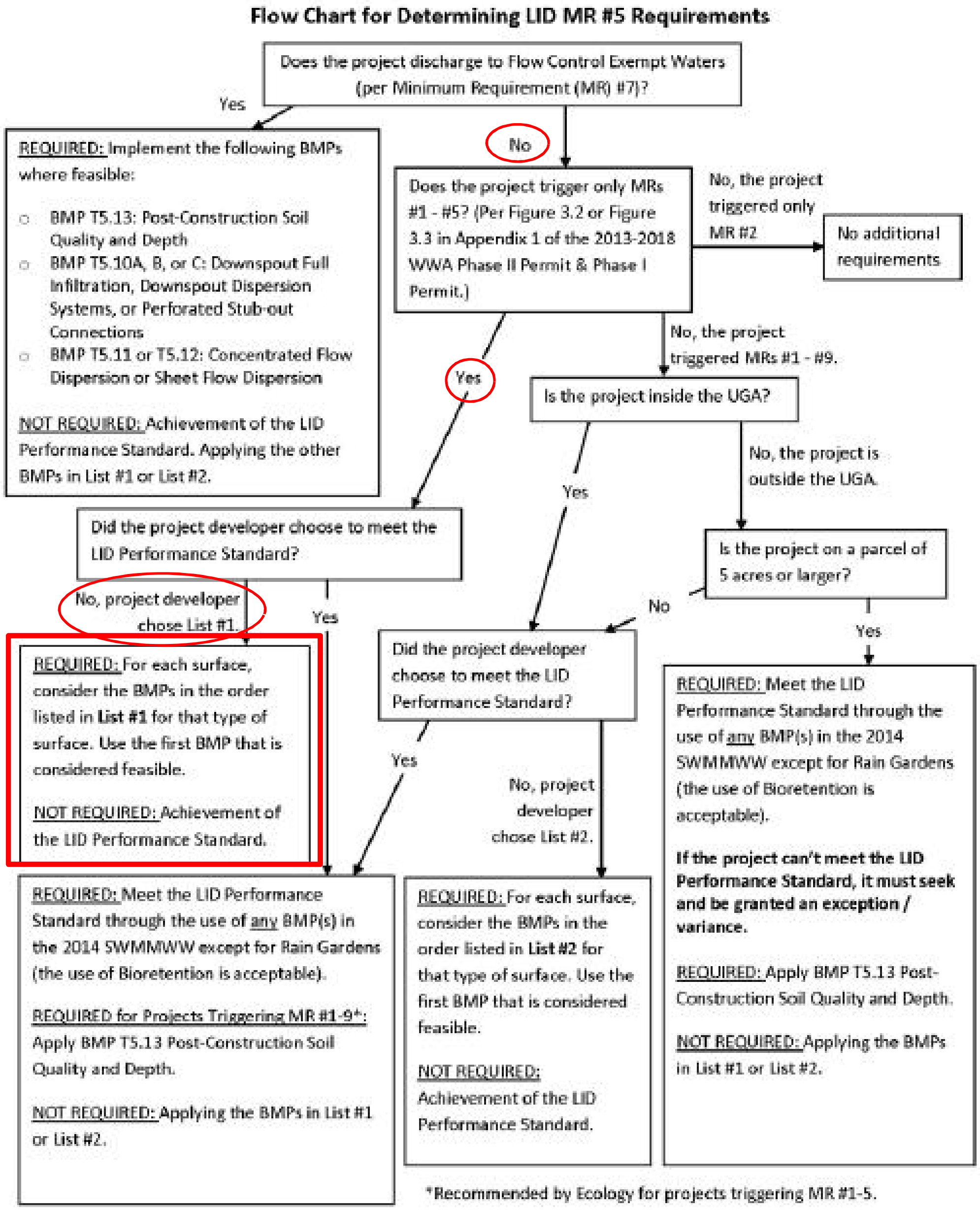
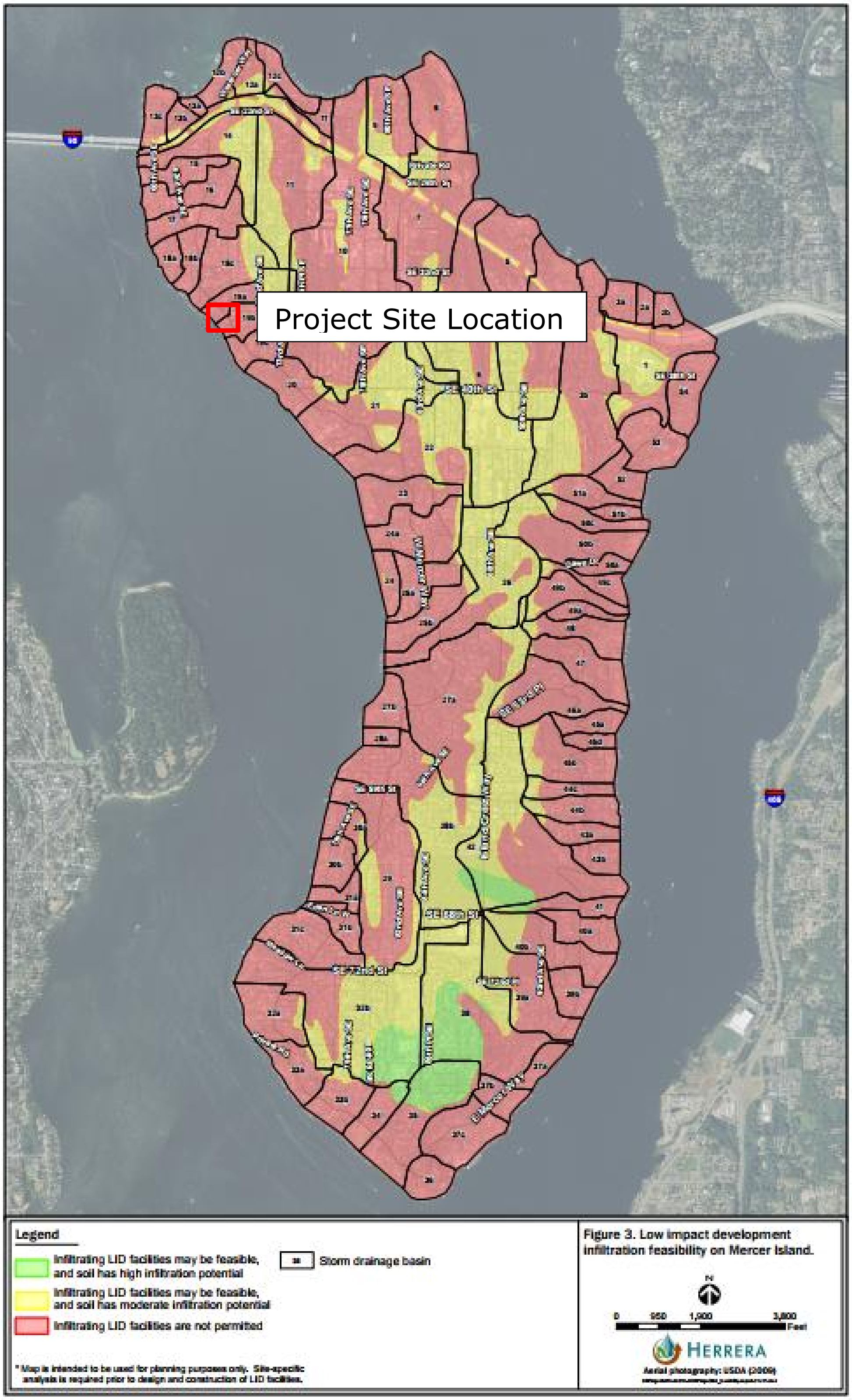


Figure 2.5.1 – Flow Chart for Determining LID MR #5 Requirements

Volume I – Minimum Technical Requirements – December 2014
2-28


Project Site Location
Legend
Infiltrating LID facilities may be feasible, and soil has high infiltration potential
Infiltrating LID facilities may be feasible, and soil has moderate infiltration potential
Infiltrating LID facilities are not permitted
Storm drainage basin
* Map is intended to be used for planning purposes only. Site-specific analysis is required prior to design and construction of LID facilities.
Figure 3. Low impact development infiltration feasibility on Mercer Island.
0
950
1,900
3,800
Feet
HERRERA
Aerial photography: USDA (2009)

Exempt Surface Waters List.

Water Body	Upstream Point/Reach for Exemption (if applicable)
Alder Lake	
Baker Lake	
Baker River	Baker River/Baker Lake downstream of the confluence with Noisy Creek
Bogachiel River	0.4 miles downstream of Dowans Creek
Calawah River	Downstream of confluence with South Fork Calawah River
Capital Lake / Deschutes River	Downstream of Tumwater Falls
Carbon River	Downstream of confluence with South Prairie Creek
Cascade River	Downstream of Found Creek
Cedar River	Downstream of confluence with Taylor Creek
Chehalis River	1,500 feet downstream of confluence with Stowe Creek
Chehalis River, South Fork	1,000 feet upstream of confluence with Lake Creek
Cispus River	Downstream of confluence with Cat Creek
Clearwater River	Downstream of confluence with Christmas Creek
Coal Creek Slough	Boundary of Consolidated Diking and Irrigation District #1 to confluence with the Columbia River.
Columbia River	Downstream of Canadian border
Consolidated Diking and Irrigations District #1	Waters that lie within the area bounded by the Columbia River on the south, the Cowlitz River on the east, Ditch No. 10 to the west, and Ditch No. 6 to the north.
Consolidated Diking and Irrigation District #3	Ditches served by these pump stations: Tam O'Shanter #1 and #2, Coweeman, Baker Way, Elk's
Coweman River	Downstream of confluence with Gobble Creek
Cowlitz River	Downstream of confluence of Ohanapecosh River and Clear Fork Cowlitz River
Crescent Lake	
Dickey River	Downstream of confluence with Coal Creek
Dosewallips River	Downstream of confluence with Rocky Brook
Dungeness River	Downstream of confluence with Gray Wolf River
Duwamish / Green River	Downstream River Mile 6 (S. Boeing Access Road)
Elwha River	Downstream of confluence with Goldie River
Erdahl Ditch in Fife	Downstream of pump station
First Creek in Tacoma	
Grays River	Downstream of confluence with Hull Creek
Green River (WRIA 26 – Cowlitz)	3.5 miles upstream of Devils Creek
Hoh River	1.2 miles downstream of Jackson Creek
Humptulips River	Downstream of confluence with West and East Forks
Johns Creek	Downstream of Interstate-405 East Right-of-way
Kalama River	2.0 miles downstream of Jacks Creek
Lacamas Lake	
Lake Cushman	
Lake Quinault	
Lake River (Clark County)	
Lake Shannon	
Lake Sammamish	
Lake Union & Union Bay	King County
Lake Washington, Montlake Cut, Ship Canal, & Salmon Bay	

Appendix I-E 2014 SWMMWW

Table 4.5.1 Vol. 5 Sec 4.5.2, 2014 SWMMWW

Table 4.5.1
Rock Protection at Outfalls

Discharge Velocity at Design Flow in feet per second (fps)	Required Protection Minimum Dimensions				
	Type	**Thickness**	**Width**	**Length**	**Height**
0 – 5	Rock lining[(1)]	1 foot	Diameter + 6 feet	8 feet *or* 4 x diameter, whichever is greater	Crown + 1 foot
5^+ - 10	Riprap[(2)]	2 feet	Diameter + 6 feet *or* 3 x diameter, whichever is greater	12 feet *or* 4 x diameter, whichever is greater	Crown + 1 foot
10^+ - 20	Gabion outfall	As required	As required	As required	Crown + 1 foot
20^+	Engineered energy dissipater required				

Footnotes:

(1) **Rock lining** shall be quarry spalls with gradation as follows:

Passing 8-inch square sieve: 100%
Passing 3-inch square sieve: 40 to 60% maximum
Passing ¾-inch square sieve: 0 to 10% maximum

(2) **Riprap** shall be reasonably well graded with gradation as follows:

Maximum stone size: 24 inches (nominal diameter)
Median stone size: 16 inches
Minimum stone size: 4 inches

Note: Riprap sizing governed by side slopes on outlet channel, assumed to be approximately 3:1 (H:V).

Appendix D – Geotechnical Report

GeoResources, LLC

Ph.253-896-1011 **5007 Pacific Hwy. E, Suite 16**
Fx.253-896-2633 **Fife, Washington 98424-2649**

March 3, 2016

Fat Boy Construction
319 Martin Street
Steilacoom, WA 98388
(206) 769-7664

Attn: Mr. Mike Boyle

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

INTRODUCTION

As requested, we are pleased to submit this preliminary 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. The stated uplift capacity would be applicable only to pin piles that are installed with tension-resisting couplings.

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
3/10/16

DANA CHRISTOPHER BIGGERSTAFF
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50040
REGISTERED
PROFESSIONAL ENGINEER
3/10/16

Keith Schembs, LEG
Principal

Dana C. Biggerstaff, PE
Senior Geotechnical Engineer

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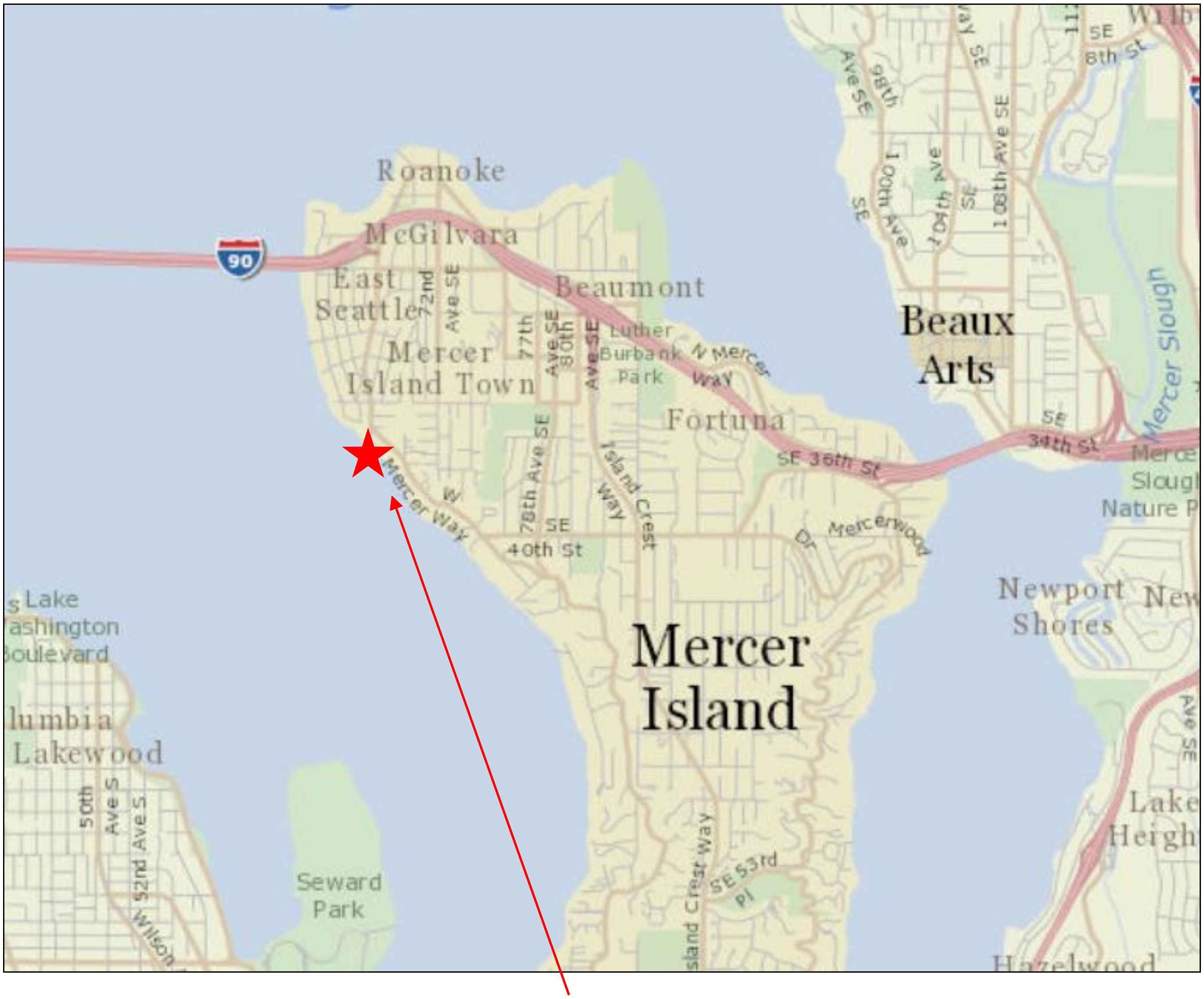
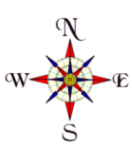
Attachments: Figure 1 – Site Location Map
Figure 2 – Conceptual Plan
Figure 3 – Site and Exploration Plan
Figure 4 – NRCS Soils Survey Map
Figure 5 – USGS Geologic Survey Map
Figure 6 – Structural Setback
Appendix A – Subsurface Explorations
Appendix B – Laboratory Test Results
Appendix C – Slope Stability Analysis



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



Not to Scale

GeoResources, LLC	Site Location Map
5007 Pacific Highway East, Suite 16 Fife, Washington 98424 Phone: 253-896-1011 Fax: 253-896-2633	Proposed Detached Garage 3603 W Mercer Way Mercer Island, Washington

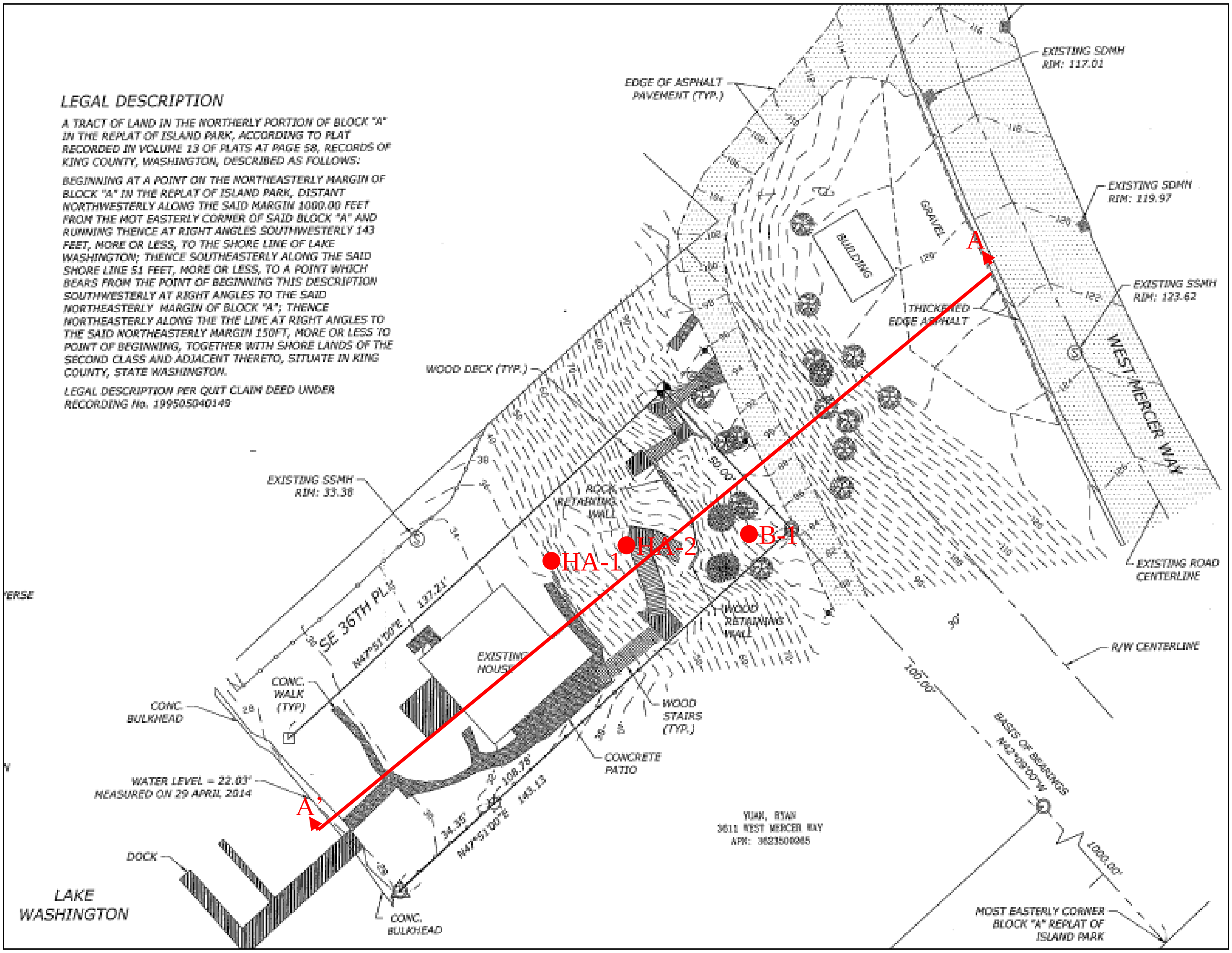
Job: FatBoyConstruction.WMercerWay.F	**November 2015**	**Figure 1**

Not to Scale

GeoResources, LLC
5007 Pacific Highway East, Suite 16
Fife, Washington 98424
Phone: 253-896-1011
Fax: 253-896-2633

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

GeoResources, LLC
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Fife, Washington 98424
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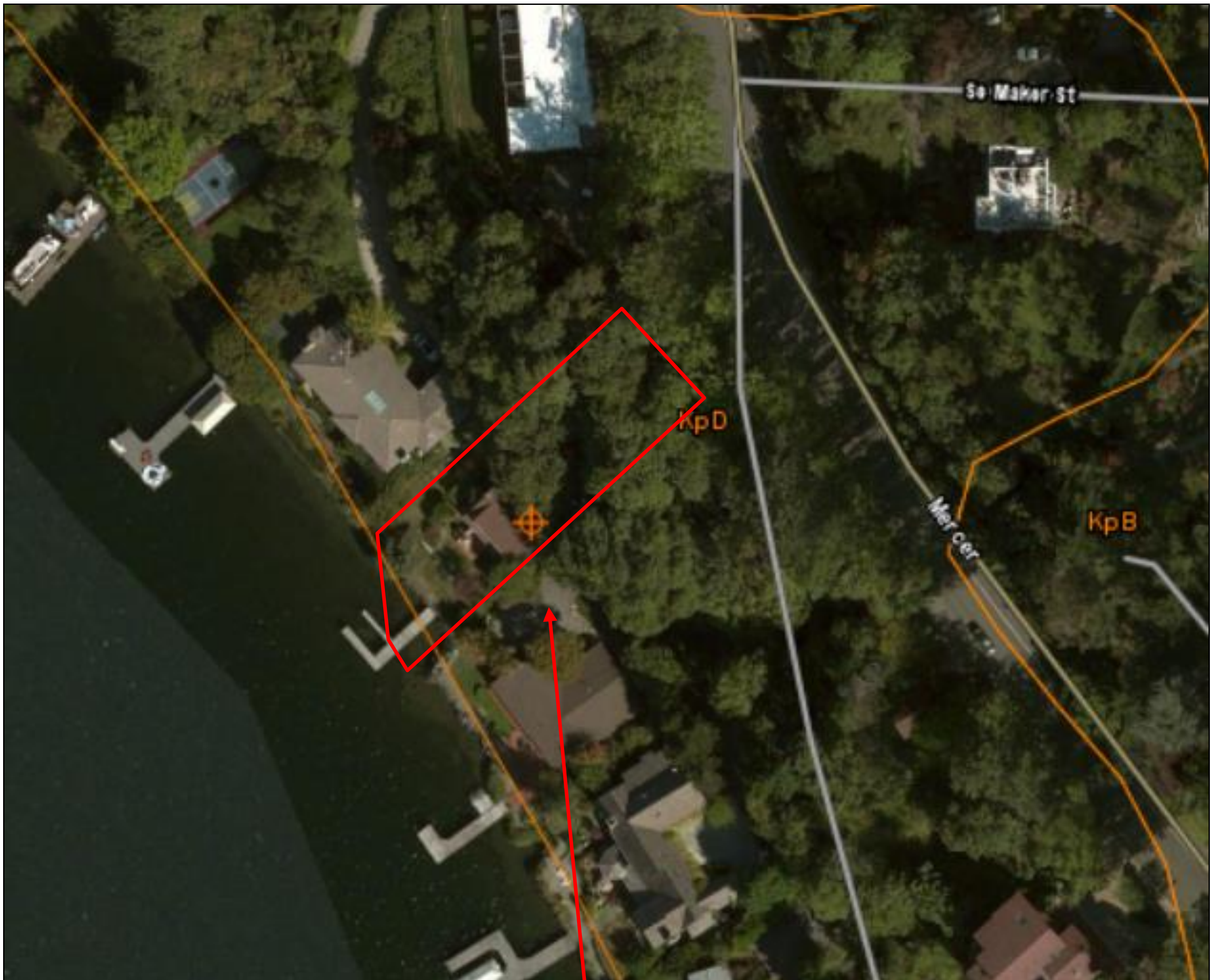
Fax: 253-896-2633

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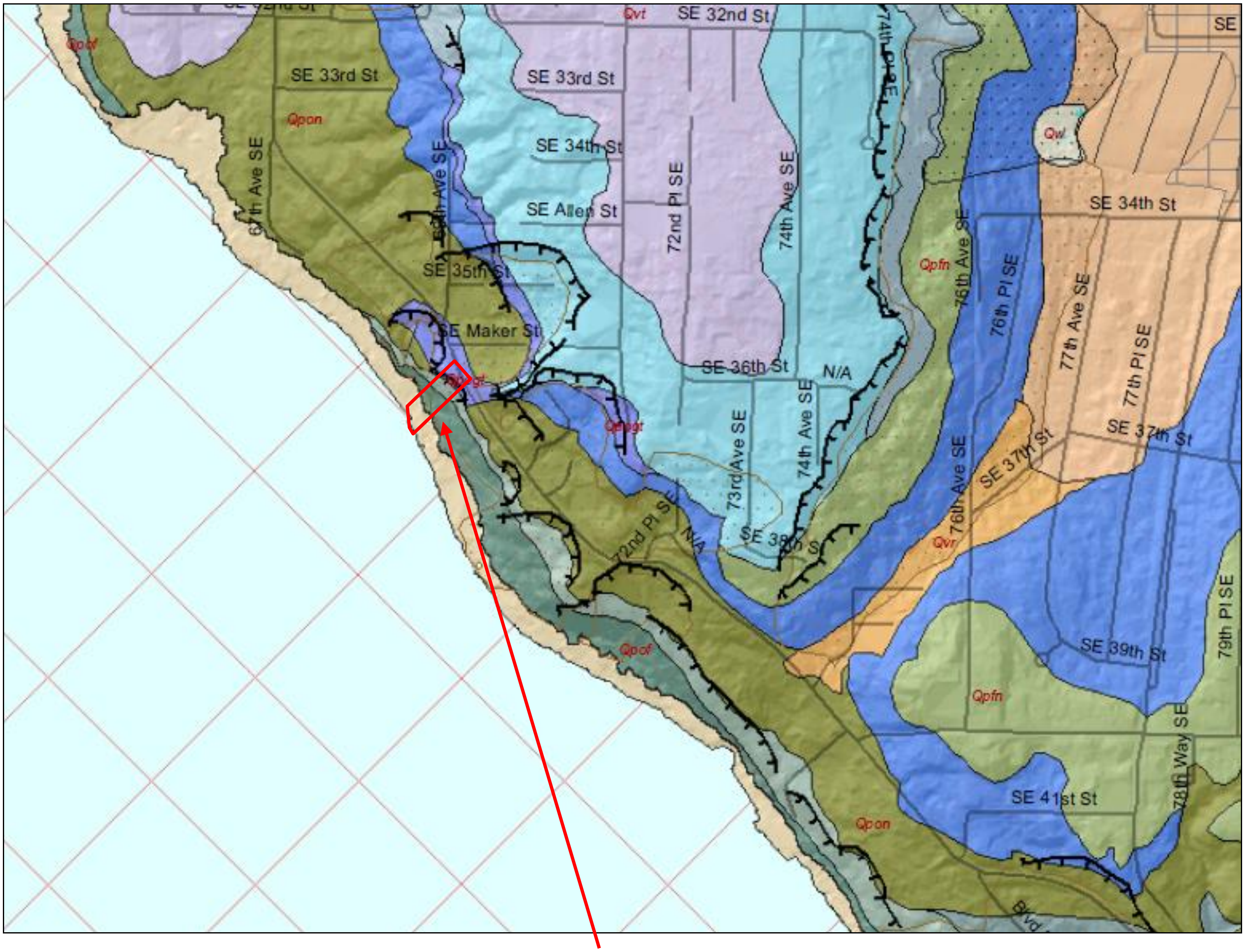
NRCS SCS Soils Map
Proposed Detached Garage
3603 W Mercer Way
Mercer Island, Washington

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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Fax: 253-896-2633

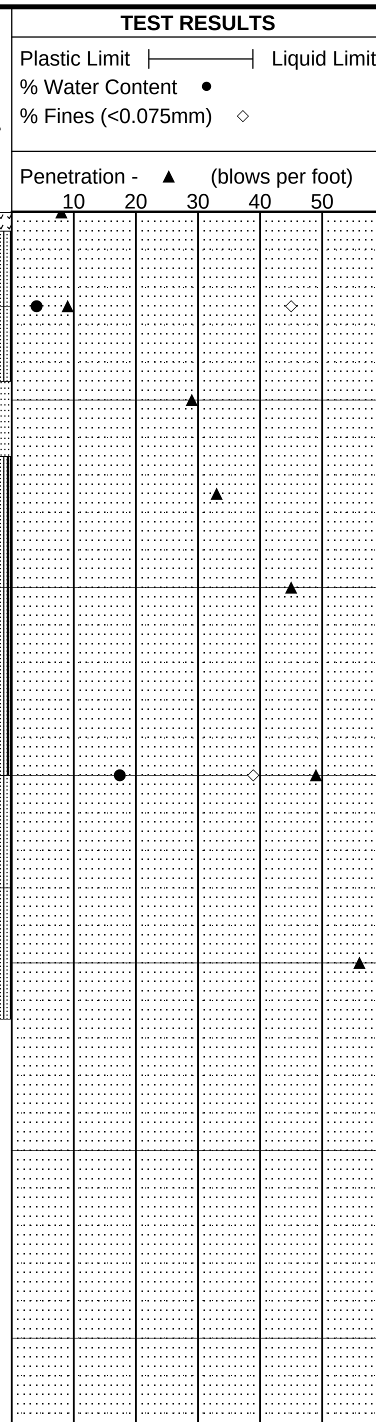
Unified Soil Classification System
Proposed Detached Garage
3603 W Mercer Way
Mercer Island, Washington

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	Sampler	Symbol	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



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
5007 Pacific Highway East, Suite 16
Fife, Washington 98424
Phone: 253-896-1011
Fax: 253-896-2633

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

Job: FatBoyConstruction.WMercerWay.F | November 2015 | **Figure A-3**

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

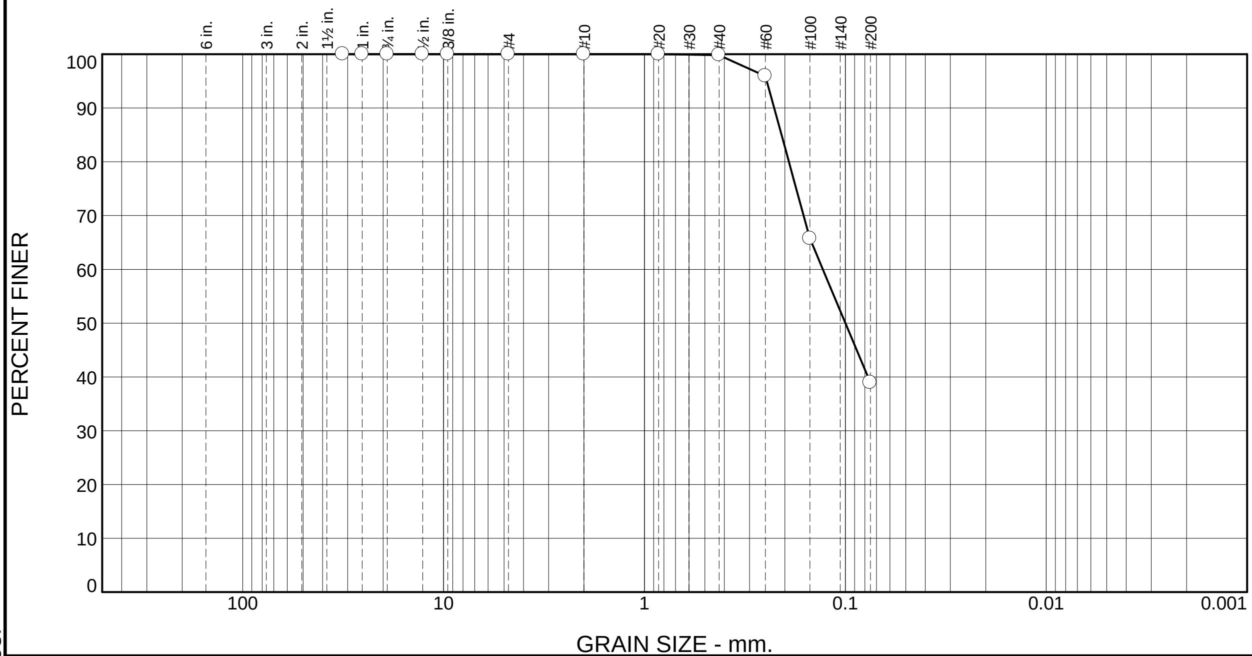
GeoResources, LLC

Fife, WA

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

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

GeoResources, LLC

Fife, WA

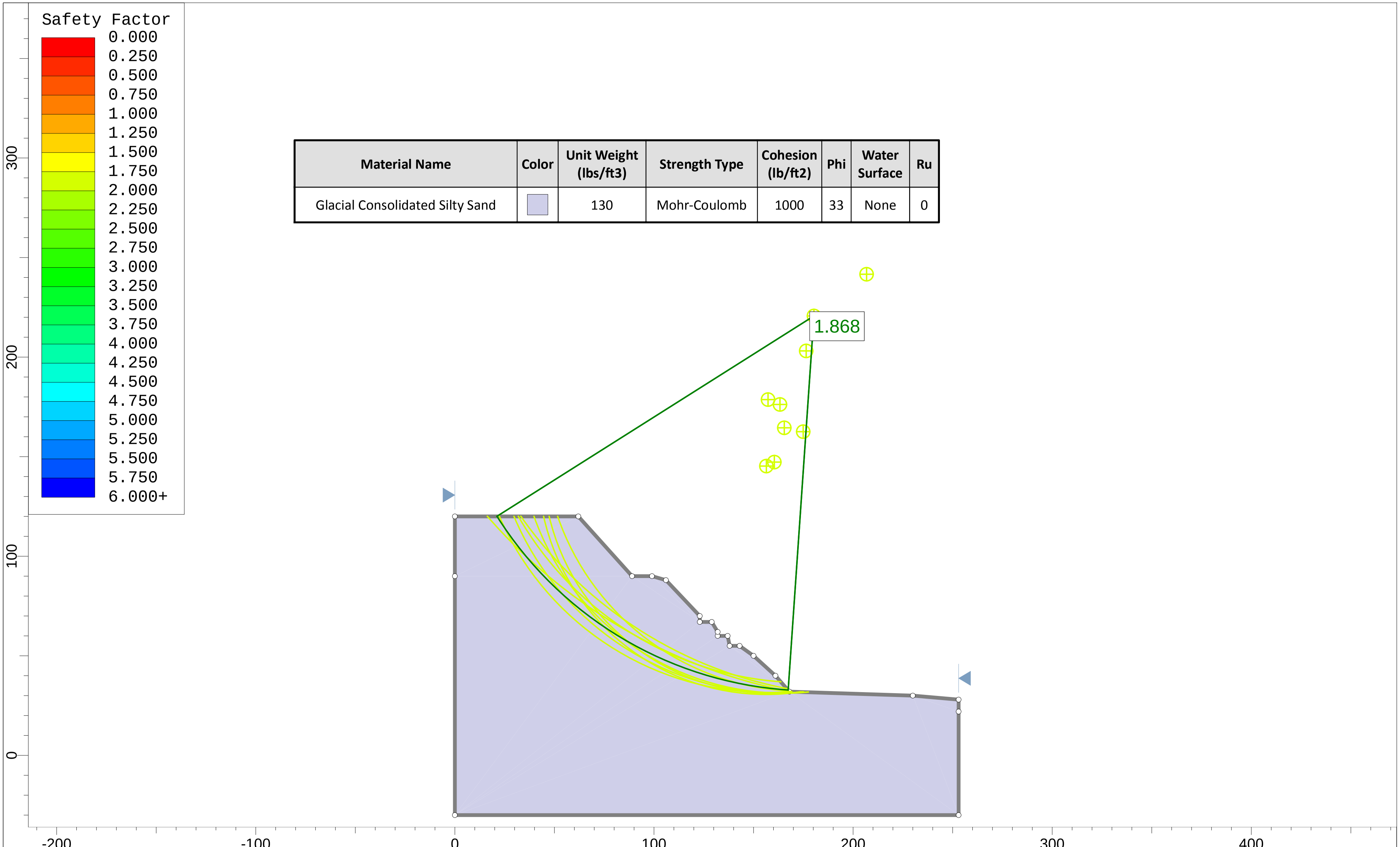
Client: Mike Boyle c/o Fatboy Construction
Project: Proposed SFR
Project No: Boyle.WMercerWay **Figure** B-2

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:** ____________

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

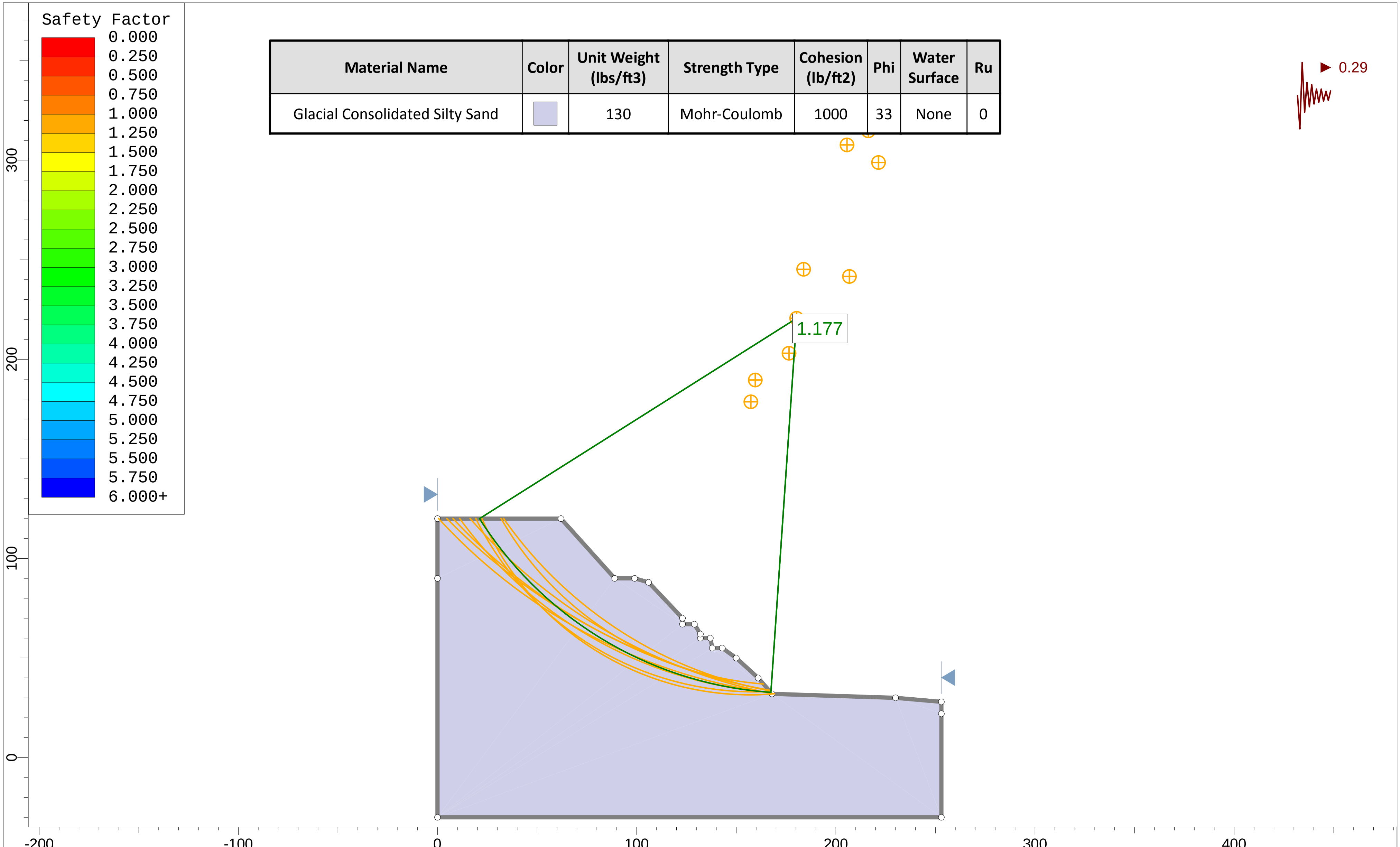
Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	21.0865	120	0	0	0
2	26.9386	111.287	-3927.48	-280.715	4.08824
3	32.7907	103.51	-3288.92	-466.441	8.07197
4	38.6428	96.4945	165.989	34.8464	11.856
5	44.495	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

Appendix E – OHWM Report

Sewall Wetland Consulting, Inc.
PO Box 880
Fall City, WA 98024
Phone: 253-859-0515

May 1, 2018

Mike Boyle
3603 West Mercer Way
Mercer Island, Washington 98040

RE: 3603 West Mercer Way – Ordinary High Water Mark
SWC Job#18-128

Dear Mike,

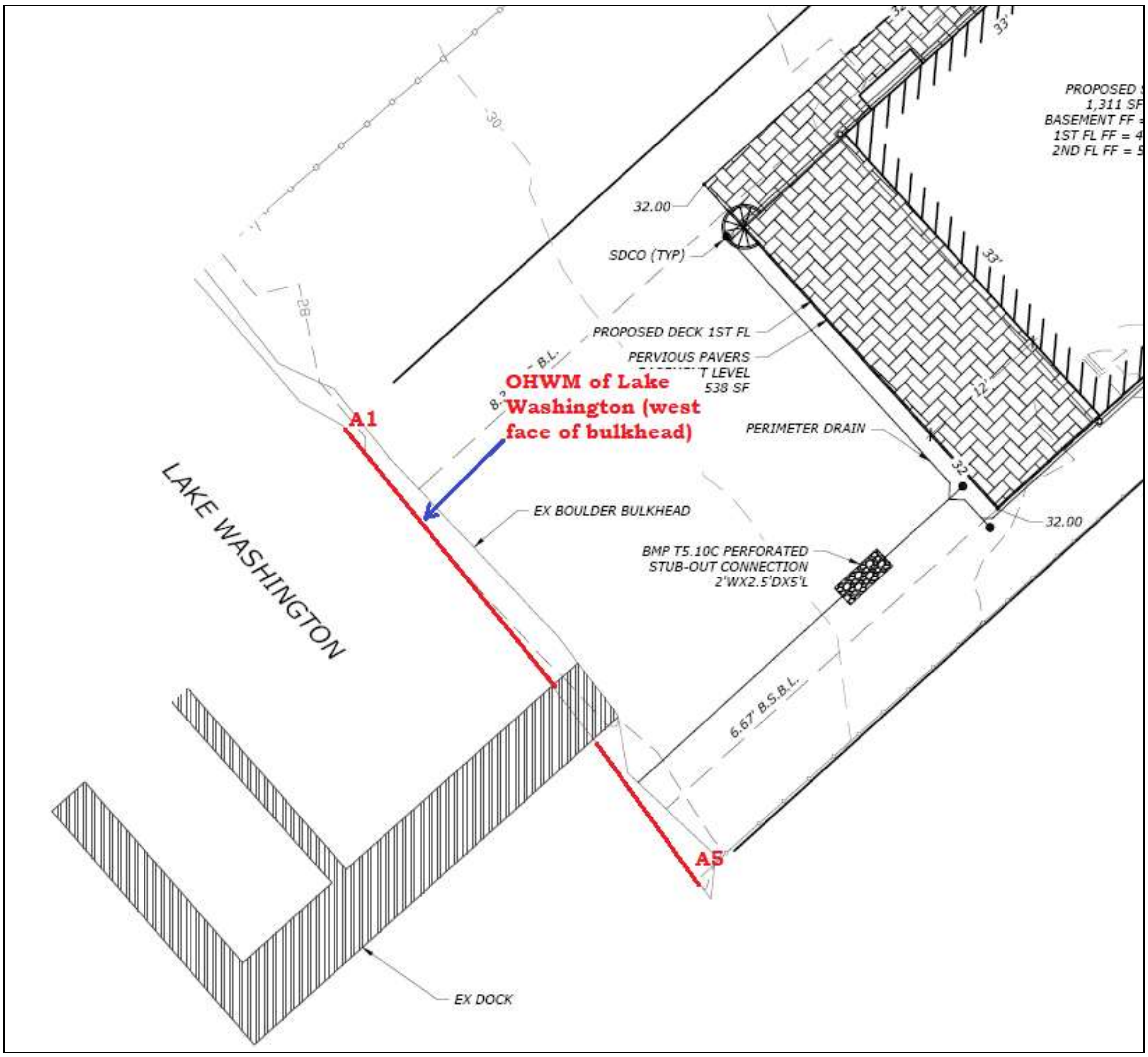
This report describes our observations of the location of the shoreline Ordinary High Water Mark (OHWM), on Parcel #3623500260, located at 3603 West Mercer Way, in the City of Mercer Island, Washington (the "site").

Above: Vicinity map of the site.

The site is an irregular shaped 0.19 acre parcel located within the SW ¼ of Section 12 Township 24 North, Range 4 East of the W.M.

Observations

Ed Sewall of Sewall Wetland Consulting, Inc. inspected the site on April 25, 2018.   The site contains and existing home and deck with associated lawn, landscaped areas and dock along the edge of Lake Washington.

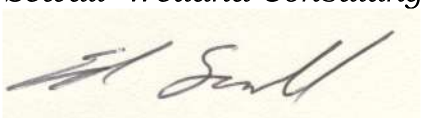


Above: Mapping of the OHWM of Lake Washington along west edge of site.

The west edge of the site consists of a bulkhead constructed of boulders. The west face of this bulkhead is a vertical to the waters of the lake and denotes the OHWM of the lake. This edge was flagged with orange flags labeled A1-A5 (*see photos Page 5&6 of this report*).

If you have any questions in regards to this report or need additional information, please feel free to contact me at (253) 859-0515 or at esewall@sewallwc.com .

Sincerely,
Sewall Wetland Consulting, Inc.



Ed Sewall
Senior Wetlands Ecologist PWS #212

REFERENCES

City of Mercer Island Municipal Code

Cowardin, L., V. Carter, F. Golet, and E. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service, FWS/OBS-79-31, Washington, D. C.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1. U. S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Muller-Dombois, D. and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley & Sons, Inc. New York, New York.

Munsell Color. 1988. Munsell Soil Color Charts. Kollmorgen Instruments Corp., Baltimore, Maryland.

National Technical Committee for Hydric Soils. 1991. Hydric Soils of the United States. USDA Misc. Publ. No. 1491.

Reed, P., Jr. 1988. National List of Plant Species that Occur in Wetlands: Northwest (Region 9). 1988. U. S. Fish and Wildlife Service, Inland Freshwater Ecology Section, St. Petersburg, Florida.

Reed, P.B. Jr. 1993. 1993 Supplement to the list of plant species that occur in wetlands: Northwest (Region 9). USFWS supplement to Biol. Rpt. 88(26.9) May 1988.

USDA NRCS & National Technical Committee for Hydric Soils, September 1995. Field Indicators of Hydric Soils in the United States - Version 2.1

Western Mountains, Valleys and Coast Regional Supplement (Version 2.0) dated June 24, 2010. USACOE

Washington State Wetlands Rating System for Western Washington Publication #04-06-025 dated August 2004, Revised 2008.

Appendix F – Construction Stormwater Pollution Prevention Plan

3603 W Mercer Way Mercer Island, WA 98040

Construction Stormwater Pollution Prevention Plan

Prepared for: **Mike Boyle**
Fatboy Construction
PO Box 44429

May 14th, 2018

Prepared by: **Kaycee Doty, EIT**

Reviewed by: **Dan Budsberg, P.E.**
Beyler Consulting
5920 100th St. SW Ste #25
Lakewood, WA 98499
(253) 301-4157

Project Number: 17-196
Project Name: Mike Boyle W Mercer Way
17-196 Mike Boyle W Mercer Way CSWPPP

TABLE OF CONTENTS

I. Construction Pollution Prevention Plan

Section 1 – Project Overview

This project proposes to construct a new single-family residence with detached garage, associated driveway, and utilities. The proposed development includes associated grading, and landscaping. The subject property's address is 3603 W Mercer Way Mercer Island, King County, WA 98040.

The proposed development of the site will be done using traditional development standards in accordance with the 2014 Stormwater Management Manual for Western Washington (2014 SWMMWW). This report accompanies the drainage plan submittal for the development of this parcel in Mercer Island, WA.

The subject parcel is rectangular in shape approximately 0.16 acres (7,097 sf) in size, 50 feet wide and 143 feet deep, in the zoned R-15 area within the City of Mercer Island. The parcel is currently developed occupied by an existing single-family residence situated on the flatter, lower, western portion of the site. The east side of the parcel sits on a hill with a vertical relief of 60 feet with slopes as great as great as 65-80%. The west side of the parcel is relatively flat with average slopes of 8% and vertical relief of 8 feet. The new house is proposed in the same location as the existing house, on the west side of the property, and the garage will be located at the top of the hill on the east side of the parcel. The proposed garage will utilize the existing access road to the east of the property.

The site is bordered by developed single family properties to north and south. It is bordered by single-family access road to the east and Lake Washington to the west.

At the time of soil exploration by the geotechnical engineer, there is was no evidence of perched seasonal groundwater. However, the geotechnical report states that due to the mapped stratigraphy of the site perched groundwater is anticipated during times of high precipitation. Per Mercer Island's Low Impact Development infiltration feasibility map, infiltration is not permissible on the project site (provided in Appendix D). Further detail can be found in the geotechnical report provided by GeoResources, dated November 3, 2015 located in Appendix D of this report.

Stormwater management for the project site is proposed to consist of collection of stormwater from the proposed roofs and asphalt driveway, and tightlined to the west, where it will be discharged into Lake Washington. The proposed back patio will implement pervious pavers.

Section 2 – Erosion Control Specialist

An erosion control specialist is not required for the size and scope of this residential single family project. It will be responsibility of the owner and/or the contractor to regularly inspect and maintain the proposed erosion control BMPs, and will take additional measures, as necessary, to respond to changing site conditions. Should it become necessary, the engineer will be made available in providing recommendations for additional erosion measures to the site.

Section 3 – Existing Site Conditions

The parcel is currently developed occupied by an existing single-family residence situated on the flatter, lower, western portion of the site. The east side of the parcel sits on a hill with a vertical relief of 60 feet with slopes as great as great as 65-80%. The west side of the parcel is relatively flat with average slopes of 8% and vertical relief of 8 feet.

Section 4 – Adjacent Areas

The site is bordered by developed single family properties to north and south. It is bordered by single-family access road to the east and Lake Washington to the west.

Section 5 – Critical Areas

The geotechnical study, prepared GeoResources on November 3, 2015, states the steep slopes on the east side of the parcel present steep slope hazard areas, potential landslide areas, historic landslide hazard area, and erosion hazard areas.

Section 6 – Soils

At the time of soil exploration by the geotechnical engineer, there is was no evidence of perched seasonal groundwater. However, the geotechnical report states that due to the mapped stratigraphy of the site perched groundwater is anticipated during times of high precipitation. Per Mercer Island's Low Impact Development infiltration feasibility map, infiltration is not permissible on the project site (provided in Appendix D). Further detail can be found in the geotechnical report provided by GeoResources, dated November 3, 2015 located in Appendix D of this report.

Section 7 – Potential Erosion Problems

The geotechnical study, prepared GeoResources on November 3, 2015, states the steep slopes on the east side of the parcel present erosion hazard areas.

Section 8 – Construction Stormwater Pollution Prevention Elements

The required elements per the Pierce County stormwater manual are listed below. Refer to the latest stormwater manual for further BMP detail as listed below.

Element 1: Preserve Vegetation/Mark Clearing Limits

The clearing limits shall be marked per the approved plans. Prior to beginning land disturbing activities, including clearing and grading, all clearing limits will be clearly marked. Silt fence will be placed on downstream property boundaries as indicated on the project plans.

The duff layer, native top soil, and natural vegetation should be retained in an undisturbed state to the maximum extent practicable. If it is not practicable to retain the duff layer in place, it should be stockpiled on site, covered to prevent erosion, and replaced immediately upon completion of the ground disturbing activities. Tree protection fences will be erected around preserved trees during construction per the City of Mercer Island's tree care guidelines.

Limit the site clearing and grading activities to the relatively dry months.

BMP C101: Preserving Natural Vegetation
BMP C102: Buffer Zones
BMP C103: High Visibility Plastic Fence

Element 2: Establish Construction Access

It is anticipated that one construction entrance will be established on this project site. With the use of this construction entrance vehicle access to and from the site is expected to track only minor amounts of dirt and other sediment onto the street.

All sediment that is tracked onto the roadway due to construction activities should be cleaned at the end of each working day. Should sediment tracked onto the street become excessive, operations will cease until the tracked material has been removed by street sweeping or shoveling.

Wheel wash or tire baths should be located on site, if the stabilized construction entrance is not effective in preventing sediment from being tracked onto roads/accesses.

BMP C105: Stabilized Construction Entrance

Element 3: Control Flow Rates

It is anticipated that flow rates will be fairly high considering the topography of the site. Therefore, a brush barrier shall be installed parallel to the bulkhead in order to reduce runoff velocities prior to entering Lake Washington.

BMP C231: Brush Barrier

Element 4: Install Sediment Controls

Prior to surface water leaving the construction site, the stormwater runoff from disturbed areas shall pass through a sediment removal BMP.

The SWPPP plan for this project specifies the use of various erosion/sediment control measures: construction entrance and siltation fence. These facilities should be inspected weekly at the end of the work week and subsequent to each storm event. Sediment accumulation in excess of design limits will be removed from the facilities upon identification of the condition and prior to a forecasted storm event. The construction superintendent, or owner, will be responsible for these actions and will be responsible for maintenance of the erosion and sediment control facilities. Site demolition and/or grading shall not occur on the site until after the silt fences have been installed.

Additionally, a brush barrier is proposed downhill of the single-family residence construction. With steep slopes on the east side of the project site, the brush barrier will aid in preventing sediment erosion from reaching Lake Washington in case of high rain events. See TESC plans for more detail about design and placement. The brush barrier should be constructed before clearing and grading is initiated.

BMP C230: Silt Fence along the downhill side of the construction area that will be disturbed. The silt fence should be in place before clearing and grading is initiated.

BMP C231: Brush Barrier

Element 5: Stabilize Soils

The following constraints will apply. From October 1 through April 30, no soils will remain exposed and unworked for more than 2 days. From May 1 to September 30, no soils will remain exposed and unworked for more than 7 days. This condition will apply to all soils on site, whether at final grade or not. The areas outside of the roadway will be stabilized with mulch, grass planting or other approved erosion control treatment during the construction phase.

BMP C120: Temporary and Permanent Seeding
BMP C121: Mulching
BMP C122: Nets and Blankets

BMP C123: Plastic Covering
BMP C140: Dust Control

Element 6: Protect Slopes

There will be no construction or clearing in the location of the steep slopes on the site. Clearing limits are to be established and silt fence provided to protect the neighboring property from sediment runoff during construction. There should be no fill within 10 feet of steep slopes. The geotechnical report, prepared by GeoResources (Appendix D), discusses considerations for protecting the steep slopes. It is the responsibility of the contractor to implement these BMP's as seen fit.

BMP C120: Temporary and Permanent Seeding
BMP C123: Plastic Covering

Element 7: Protect Drain Inlets

All storm drain inlets made operable during construction shall be protected so that stormwater runoff does not enter the conveyance system without first being filtered or treated to remove sediment.

All approach roads shall be kept clean. Sediment and street wash wastewater shall be controlled as specified above in Element #2.

Inlets should be inspected weekly at a minimum and daily during storm events. Inlet protection devices should be cleaned or removed and replaced when sediment had filled on-third of the available storage.

However, there are no anticipated drain inlets that will need protection during construction as they located at a higher elevation. If sediment is tracked offsite, then the catch basins in W Mercer Way shall be protected.

BMP C220: Storm Drain Inlet Protection

Element 8: Stabilize Channels and Outlets

There are no channels either existing or proposed nor are there any existing or proposed outlets to channels.

Element 9: Control Pollutants

Control of pollutants are the responsibility of the construction superintendent. Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities that may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces will be cleaned immediately following any discharge or spill incident. The superintendent will be expected to use his best judgment in addressing any and all conditions that are potentially damaging to the environment. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.

All pollutants, including waste materials and demolition debris that occur on-site during construction will be handled and disposed of in a manner that does not cause contamination of stormwater. Cover, containment, and protection from vandalism will be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the site.

The contractor will provide a centralized area for the storage, maintenance, and refueling of construction equipment and for washing of concrete truck drums. All runoff from the area shall be intercepted by a trench around the downslope side of the area and detained until it can be removed by a 'Vactor' truck and properly disposed of in an approved facility.

BMP C151: Concrete Handling
BMP C152: Saw cutting and Surfacing Pollution Prevention

Element 10: Control De-Watering

No requirement for de-watering is anticipated. However, if encountered, de-watering shall be discharged into a closed conveyance system for discharge from the site. Highly turbid or otherwise contaminated dewatering water, such as from construction equipment operation will be handled separately from stormwater.

Element 11: Maintain BMPs

All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair will be conducted in accordance with standard procedures for the BMPs.

Sediment control BMPs will be inspected weekly or after a runoff-producing storm event during the dry season and daily during the wet season.

All temporary erosion and sediment control BMPs should be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal of BMPs or vegetation will be permanently stabilized with mulch, grass planting or other approved erosion control treatment.

Element 12: Manage the Project

Site construction will be performed after the erosion and sediment control measures have been constructed.

From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if the transport of sediment from the construction site to receiving waters will be prevented through a combination of favorable site and weather conditions, limitations on extent of activity, and proposed erosion and sediment control measures. The Contractor and/or owner should stop the permitted activity if sediment leaves the construction site causing a violation of the surface water quality standard or if erosion and sediment control measures are not adequately maintained.

Trenches should be opened only immediately prior to construction and the trenches should be backfilled immediately after any required testing or inspections of the installed improvements. Trenching spoils should be treated as other disturbed earthwork and measures will be taken to cover or otherwise stabilize the material, as required.

All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. The construction SWPPP shall be retained on site or within reasonable access to the site.

The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to water of the state.

BMP C160: Certified Erosion and Sediment Control Lead
BMP C162: Scheduling

Element 13: Protect Low Impact Development BMPs

This project does not propose any LID BMPs such as bioretention, pervious pavement, or rain gardens, therefore this element does not specifically apply. However, all BMPs used onsite will be maintained per Element 11.

Section 9 – Construction Phasing

The recommended construction sequence will include these steps in this order, but some portions of the steps may be performed out of sequence as conditions require.

The Construction Sequence is as follows:

1. Stake and flag clearing and construction limits
2. Install Construction Entrance(s)
3. Install silt fabric fence where indicated
4. Install any other erosion control facilities that may be necessary
5. Call Pierce County for Erosion Control Inspection
6. Clear and grade site
7. Remove erosion control facilities only after site is stabilized
8. Request Final site development inspection

All storm drainage facilities shall be protected in place from construction activity via brightly flagged stakes or, if necessary, temporary construction fencing.

Section 10 – Construction Schedule

The project is intended to begin construction in the Summer of 2018. Special consideration is required for source control during the wet season period, which may include phased construction, materials available for immediate stabilization of denuded areas and diligent review of site for noted erosion concerns.

Section 11 – Financial/Ownership Responsibilities

The property owner will be responsible for bonds and other required securities for this project.

Section 12 – Engineering Calculations

No calculations were required during the construction of this SWPPP plan.

Section 13 – Conclusion

Erosion control procedures as described in this report and illustrated on the design plans, if properly implemented, should mitigate anticipated erosion effects from the development of this project.

The success of erosion control measures is usually related to the Contractor's attention to maintenance of such measures. However, in some instances, even with proper attention being paid to erosion control, measures such as those shown on the plans are unable to prevent the discharge of turbid water to the city storm system. In this event, secondary measures may be required. These additional BMPs are provided in Volume II of the 2014 SWMMWW.