
STORM DRAINAGE REPORT

# STORM DRAINAGE REPORT

## for

## Koneru SFR
## 6610 East Mercer Way
## Mercer Island, WA 98040

December 2021


Dheeraj Koneru
7002 93rd Avenue SE
Mercer Island, Washington 98040


PACE
An Engineering Services Company

# KONERU SFR

# DRAINAGE REPORT

Prepared For:

Dheeraj Koneru
6610 East Mercer Way
Mercer Island, Washington 98040

December 2021

Prepared By:

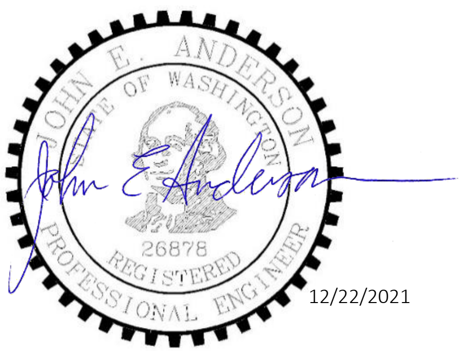

John Anderson, PE
PACE Engineers, Inc.
11255 Kirkland Way, Suite 300
Kirkland, WA 98033-3417
*p.* 425.827.2014 | *f.* 425.827.5043

PACE Project No. 21436

*THIS PAGE IS INTENTIONALLY LEFT BLANK.*

# PROJECT CERTIFICATION

The technical material and data contained in this report was prepared by PACE Engineers, Inc., under the supervision of the below listed individuals. Those responsible staff members who are registered professional engineers are licensed in the State of Washington.




12/22/2021

John E. Anderson, PE

PACE Engineers, Inc.
11255 Kirkland Way, Suite 300
Kirkland, Washington 98033-3417
Phone: 425.827.2014
www.paceengrs.com

*THIS PAGE IS INTENTIONALLY LEFT BLANK.*

# TABLE OF CONTENTS

SECTION# TITLE PAGE #

## LIST OF TABLES



## LIST OF FIGURES



## APPENDICES

# 1. PROJECT OVERVIEW

The project site is located at 6610 East Mercer Way in the city of Mercer Island, King County, Washington. The project is located within the northeast quarter of Section 30, Township 24N, Range 05E, with a parcel number of 302405-9153. The parcel has a total area of 1.15 acres. See Figure 1 on the following page for the vicinity map. The existing single-family residence and driveway will be demolished, and a single-family residence will be constructed.

This hydrological assessment was completed after review of the following information: The ALTA survey of the property which included topographic and boundary map information; historical storm data (King County); the included Geotechnical Engineering Study and Critical Area Study by Geotech Consultants (see Appendix B); available SCS soil maps; and City GIS Storm Drainage maps.

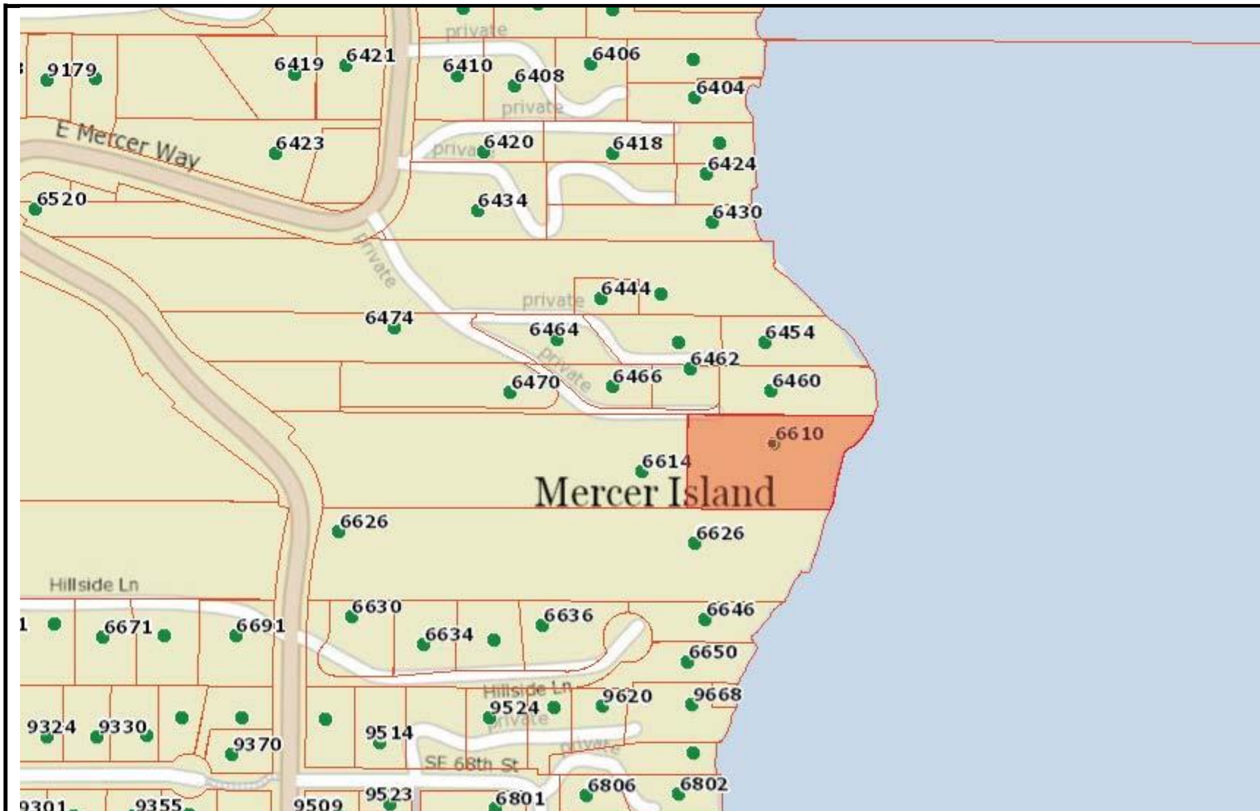
Stormwater runoff from the property generally sheet flows from west to east where it discharges directly into Lake Washington. The offsite sheet flow will be collected using gravel interceptor trenches under developed conditions. The gravel interceptor trenches will discharge to Lake Washington using a private storm system.

## General Project Description

Proposed development of the property will include the construction of one single-family residence, associated driveway, and associated utilities. Stormwater from impervious surfaces (roof and driveway runoff) will be collected via the proposed private storm drainage system and discharged directly into Lake Washington.

A 36-inch CMP storm pipe is located on the northern property line of the site. This pipe is a non-fish bearing piped watercourse. Providing an open channel within the property has been determined to be infeasible, see letter from geotechnical engineer in Appendix B. This project is not proposing any changes, or connections to the existing 36" storm line.

Per Mercer Island Municipal Code 15.09.050, on-site detention is not required if the project discharges directly into Lake Washington. This project is proposing to discharge stormwater directly into Lake Washington and is therefore exempt from providing a flow control facility.




| | | |
|---|---|---|
| | *Figure 1: Vicinity Map* | Project No. 21436 |
| | | December 2021 |

# 2. MINIMUM REQUIREMENTS

The proposed project is classified as a "New Development" per Figure I-2.4.1 of the 2014 Department of Ecology (Ecology) Manual. Since the project will result in more than 5,000 square feet of new plus replaced hard surface area, all minimum requirements will apply.

## 2.1 MINIMUM REQUIREMENT #1: PREPARATION OF STORMWATER SITE PLANS

Civil Plans under separate cover and a Storm Drainage Report herein have been prepared for the subject project.

## 2.2 MINIMUM REQUIREMENT #2: CONSTRUCTION STORMWATER POLLUTION PREVENTION

See Section 8 of this Report. See Erosion and Sediment Control (ESC) plans under separate cover. The SWPPP will be provided at the site development permit phase.

## 2.3 MINIMUM REQUIREMENT #3: SOURCE CONTROL OF POLLUTION

The Temporary Erosion and Sedimentation Control Plan incorporates Best Management Practices (BMPs) to minimize and manage the generation of pollutants onsite during construction. The long-term operation of the new single-family residences is not expected to generate significant pollution.

## 2.4 MINIMUM REQUIREMENT #4: PRESERVATION OF NATURAL DRAINAGE SYSTEMS AND OUTFALLS

The site is currently developed with a storm system consisting of a catch basin within the existing driveway that conveys surface water runoff and roof runoff east where it is discharged directly to Lake Washington. The proposed project will maintain the existing drainage flowpath in the developed condition.

See Section 4 of this report for further drainage basin analysis.

## 2.5 MINIMUM REQUIREMENT #5: ONSITE STORMWATER MANAGEMENT

Per Figure I-2.5.1 of the 2014 Ecology Manual, projects qualifying for flow control exemption do not have to achieve the Low Impact Development performance standard, nor consider bioretention, rain gardens, permeable pavement, and full dispersion. The remaining BMPs as listed in this section were evaluated for implementation where feasible.

- BMP T5.13: Post-Construction Soil Quality and Depth
- BMP T5.10A, B, or C: Downspout Full Infiltration, Downspout Dispersion Systems, or Perforated Stub-out Connections
- BMP T5.11 or T5.12: Concentrated Flow Dispersion or Sheet Flow Dispersion

According to City GIS stormwater map (Appendix A), stormwater infiltration is not allowed on this property. Amended soils will be used for all new and replaced green areas.

## 2.6 MINIMUM REQUIREMENT #6: RUNOFF TREATMENT

The following require construction of stormwater treatment facilities per the Ecology Manual, section 2.5.6:

- Projects in which the total of pollution-generating impervious surface (PGIS) is 5,000 square feet or more in a threshold discharge area of the project, or
- Projects in which the total of pollution-generating pervious surfaces (PGPS) is three-quarters (¾) of an acre or more in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site.

This project results in a total of approximately 4,975 square feet of PGIS and therefore will not require construction of a stormwater runoff treatment facility.

## 2.7 MINIMUM REQUIREMENT #7: FLOW CONTROL

Per Mercer Island Municipal Code 15.09.050, on-site detention is not required if the project discharges directly into Lake Washington. This project is proposing to discharge stormwater directly into Lake Washington and is therefore exempt from providing a flow control facility.

## 2.8 MINIMUM REQUIREMENT #8: WETLANDS PROTECTION

This requirement applies only to projects whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system. The subject site does not discharge to a wetland; therefore, this requirement does not apply.

## 2.9 MINIMUM REQUIREMENT #9: OPERATIONS AND MAINTENANCE MANUAL

Per Section 2.5.10 of the Ecology Manual, an operation and maintenance manual consistent with the provisions in Volume V of the 2014 Ecology Manual is required for all proposed public and private stormwater facilities including flow control and treatment facilities, conveyance systems, constructed source controls, and green infrastructure. The operations and maintenance section in Chapter 4.6, Volume V of the Ecology manual is included in Appendix D of this report.

# 3. OFFSITE ANALYSIS

*Upstream*

Upstream tributary runon from adjacent properties to the west is minimal; there are two existing open channel water courses collecting a majority of the stormwater runoff west of the project site. Runoff from the tributary area sheet flows through the project site before discharging to Lake Washington. See figures *Existing Conditions* and *Developed Conditions* in the following pages of this report.

*Downstream Resource Review*

The following resources were reviewed in preparation of this report.

- The ALTA survey of the property which included topographic and boundary map information.
- Storm System inventory maps provided by the City of Mercer Island Development Engineering department.

*Downstream Field Investigation*

The downstream analysis was performed with the assistance of stormwater inventory maps provided by the city of Mercer Island.

Site topography slopes generally from west to east. Existing on-site grades based on topography range from 2% to 22%. The site is developed with a single-family residence, a stand-alone garage, a stand-alone shed, and an asphalt driveway. At the closest point, the existing single-family residence is 105 feet from the Lake Washington ordinary high water elevation.

Surface flows on the project site generally sheet flow to the east and discharge directly to Lake Washington. There is one yard drain onsite located in the existing concrete driveway. The outlet pipe conveys runoff east before discharging to Lake Washington.

# 4. FLOW CONTROL AND WATER QUALITY ANALYSIS AND DESIGN

## A. Hydraulic Analysis

The drainage analysis used the Western Washington Hydrology Model (WWHM) software. Flow control is not required for the site as discussed in Minimum Requirement #7. Additionally, water quality is not required as discussed in Minimum Requirement #6. Developed flow frequencies will be used to verify conveyance capacity of the proposed storm drain system.

The site is located in the SeaTac rainfall region with a location scale factor of 1.0. Per the NRCS Soil Survey and a geotechnical investigation, the site soils are entirely Kitsap silt loam, (KpB), WWHM group C.

*Pre-developed Conditions*

The subject property is 1.15 acres in size, with one existing single-family residence, a driveway, a stand-alone shed, a stand-alone garage, and landscaped areas. The existing single-family residence has a footprint area of approximately 5,000 square feet. The area being considered for modeling is tabulated below. The site is comprised entirely in one drainage basin, flowing west to east.

Table 4.1: Pre-Developed On-site Basin

| Land Use | Area | | Impervious | | Pervious | |
|---|---|---|---|---|---|---|
| | (SF) | (Acre) | (SF) | (Acre) | (SF) | (Acre) |
| Driveway | 4,223 | 0.097 | 4,223 | 0.097 | 0.00 | 0.00 |
| Roof (SFR) | 4,956 | 0.114 | 4,956 | 0.114 | 0.00 | 0.00 |
| Roof (Garage) | 645 | 0.015 | 645 | 0.015 | 0.00 | 0.00 |
| Roof (Shed) | 38 | 0.001 | 38 | 0.001 | 0.00 | 0.00 |
| C, Forest, Steep | 2,560 | 0.059 | 0 | 0.00 | 2,560 | 0.06 |
| C, Forest, Mod | 37,672 | 0.865 | 0 | 0.00 | 37,672 | 0.86 |
| Total | 50,094 | 1.15 | 9,862 | 0.23 | 40,232 | 0.92 |

*Developed Conditions*

Proposed development of the property will include construction of one single-family residence and an associated driveway. The parcel owner plans to submit for a short plat application; this parcel will be subdivided into two lots and will consist of an additional single-family residence from the one proposed with this single-family

The developed basin areas are as shown in the Table 4.2.

| Table 4.2: Developed On-site Basin | | | | | | |
|---|---|---|---|---|---|---|
| Land Use | Area | | Impervious | | Pervious | |
| | (SF) | (Acre) | (SF) | (Acre) | (SF) | (Acre) |
| Non-PGIS Impervious (Roof and Patios) | 10,035 | 0.23 | 10,035 | 0.23 | 0 | 0.00 |
| PGIS Impervious (Driveway) | 4,975 | 0.12 | 4,975 | 0.12 | 0 | 0.00 |
| C, Lawn, Flat | 29,379 | 0.67 | 0 | 0.00 | 29,379 | 0.67 |
| Future SP Lot | 5,705 | 0.13 | 5,705 | 0.13 | 0 | 0 |
| **Total** | **50,094** | **1.15** | **15,010** | **0.34** | **29,379** | **0.67** |

B. Water Quality Calculations

This project results in a total of approximately 4,975 square feet of PGIS and therefore will not require construction of a stormwater runoff treatment facility.

## 5. CONVEYANCE SYSTEM ANALYSIS AND DESIGN

The tight-lined storm drainage system for the site was designed for the 100-year storm utilizing the WWHM runoff flows. See Appendix C for WWHM calculations.

Pipe conveyance calculations were performed using the Manning's equation. The minimum pipe size on the site is 6 inches with a minimum slope of 2.18%. At a slope of 2.18%, a 6-inch pipe is capable of conveying 1.20 cfs. Per WWHM, the 100-year discharge flow for the site is 0.57 cfs. Therefore, the system passes.

## 6. SPECIAL REPORTS AND STUDIES

Geotechnical Engineering Study and Critical Area Study
Prepared for: Dheeraj Koneru
Prepared by: Adam Moyer - Geotech Consultants, Inc.
Dated: June 8, 2021
Geotech Consultants, Inc.
2401 10th Ave E
Seattle, WA 98102

Geotechnical Feasibility of Watercourse Restoration
Prepared for: Dheeraj Koneru
Prepared by: Marc McGinnis - Geotech Consultants, Inc.
Dated: August 24, 2021
Geotech Consultants, Inc.
2401 10th Ave E
Seattle, WA 98102

Arborist Report
Prepared for: Dheeraj Koneru
Prepared by: Craig Bachmann – Tree133 LLC
Dated: March 1, 2021
Tree 133 LLC

## 7. OTHER PERMITS

Additional permits may include the following:

- DOE General Construction Stormwater Permit

## 8. CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

Design of the ESC plan was completed in conformance with Minimum Requirement #2 per the 2014 Ecology Manual. Compliance with the 12 minimum requirements is demonstrated in the Construction Stormwater Pollution Prevention Plan report provided under separate cover.

## 9. BOND QUANTITIES, FACILITY SUMMARIES, AND DECLARATION OF COVENANT

A bond estimate will be included with the final submittal.

## 10. OPERATIONS AND MAINTENANCE MANUAL

Applicable maintenance standards from Chapter 4.6, Volume V of the Ecology manual is included in Appendix D.

*THIS PAGE IS INTENTIONALLY LEFT BLANK.*

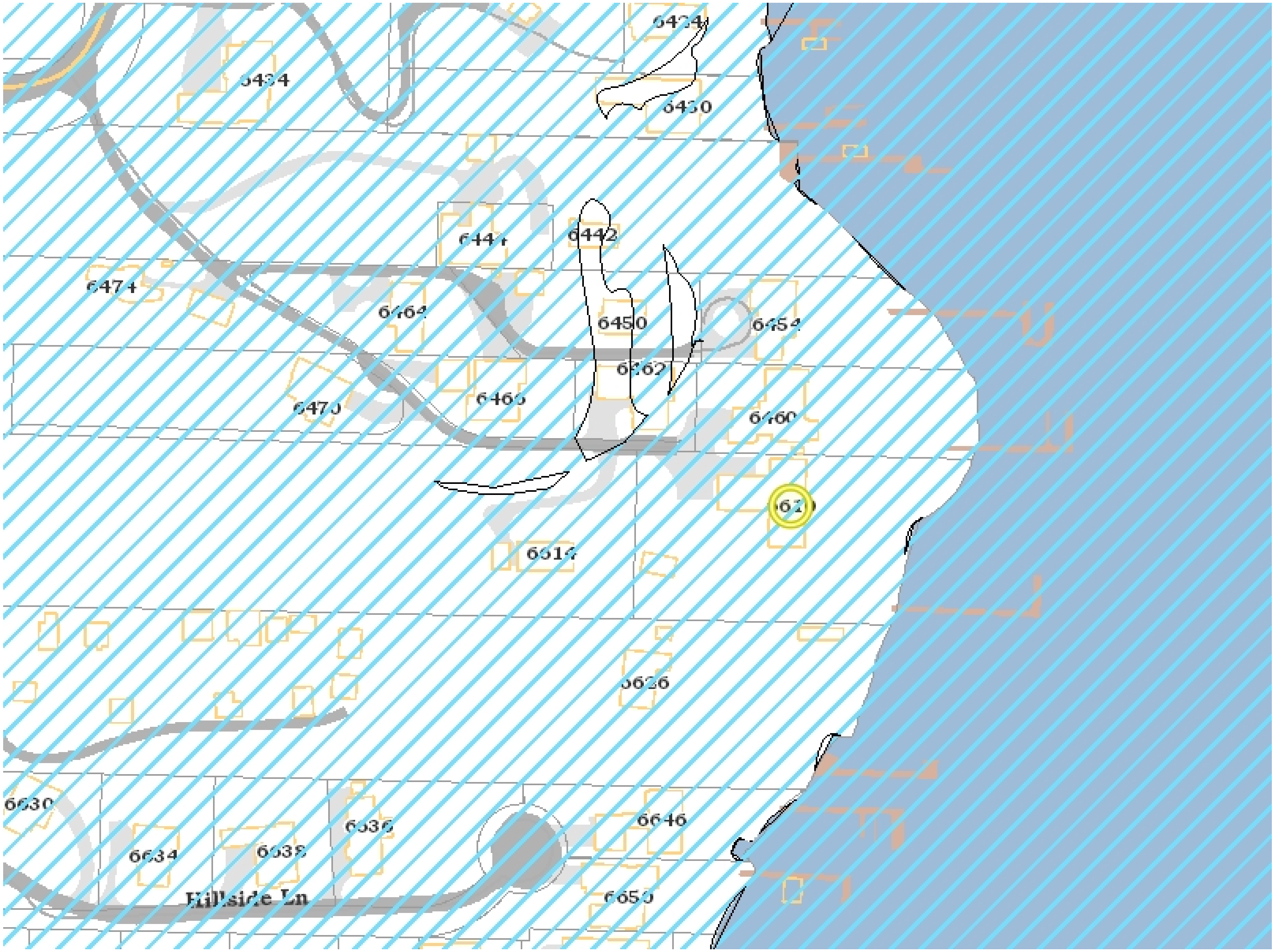
Dheeraj Koneru
Mercer Island, WA

# APPENDIX A
## Site Maps

*THIS PAGE IS INTENTIONALLY LEFT BLANK.*

Information & Geographic Services

# Potential Slide Map




## Legend

- Potential Slide
- Address
- Building
- Property Line
- Docks
- Freeway
- Major Street
- Street
- Paved Driveway
- Paved Road
- Paved Parking Area
- Parks
- Lake Washington

0 152 304 Feet

1 inch = 303.957783666667 feet



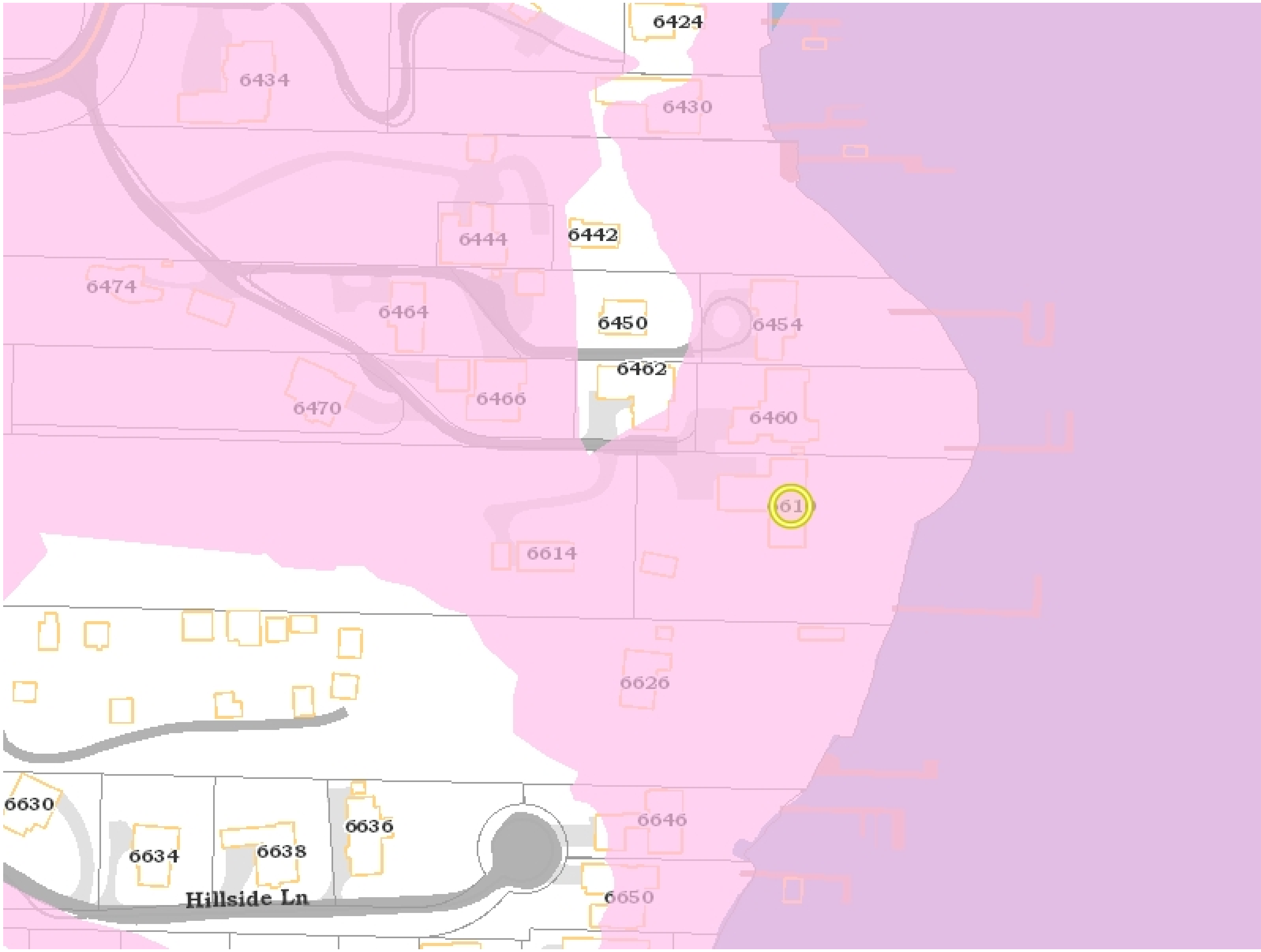
Map Printed: September 9, 2021

Disclaimer: These maps were developed by the City of Mercer Island and are intended to be a general purpose digital reference tool. These maps are not an accepted legal instrument for describing, establishing, recording or maintaining descriptions for property concerns or boundaries. The City makes no representation or warranty with respect to the accuracy or currency of these data sets, especially in regard to labeling of surveyed dimensions, or agreement with official sources such as records of survey, or mapped locations of features.

## Notes

Information & Geographic Services

# Seismic Hazard Map




## Legend

- Seismic
- Address
- Building
- Property Line
- Docks
- Freeway
- Major Street
- Street
- Paved Driveway
- Paved Road
- Paved Parking Area
- Parks
- Lake Washington

0 152 304 Feet

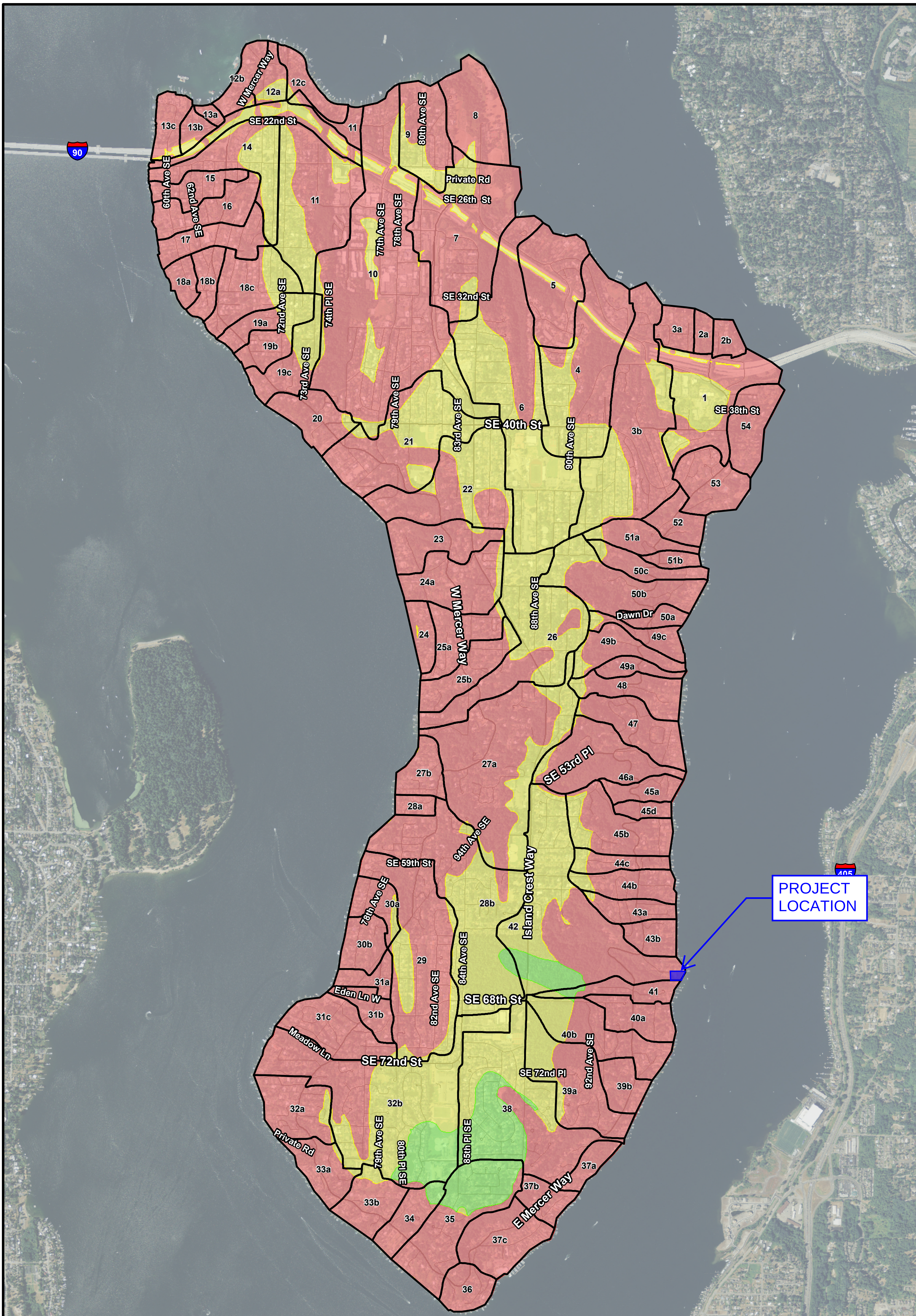
1 inch = 303.957783666667 feet

Disclaimer: These maps were developed by the City of Mercer Island and are intended to be a general purpose digital reference tool. These maps are not an accepted legal instrument for describing, establishing, recording or maintaining descriptions for property concerns or boundaries. The City makes no representation or warranty with respect to the accuracy or currency of these data sets, especially in regard to labeling of surveyed dimensions, or agreement with official sources such as records of survey, or mapped locations of features.



Map Printed: September 9, 2021

**Notes**




**Legend**

| | |
|---|---|
| (green) | Infiltrating LID facilities may be feasible, and soil has high infiltration potential |
| (yellow) | Infiltrating LID facilities may be feasible, and soil has moderate infiltration potential |
| (red) | Infiltrating LID facilities are not permitted |
| 36 | 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.**

N

0 950 1,900 3,800 Feet

HERRERA

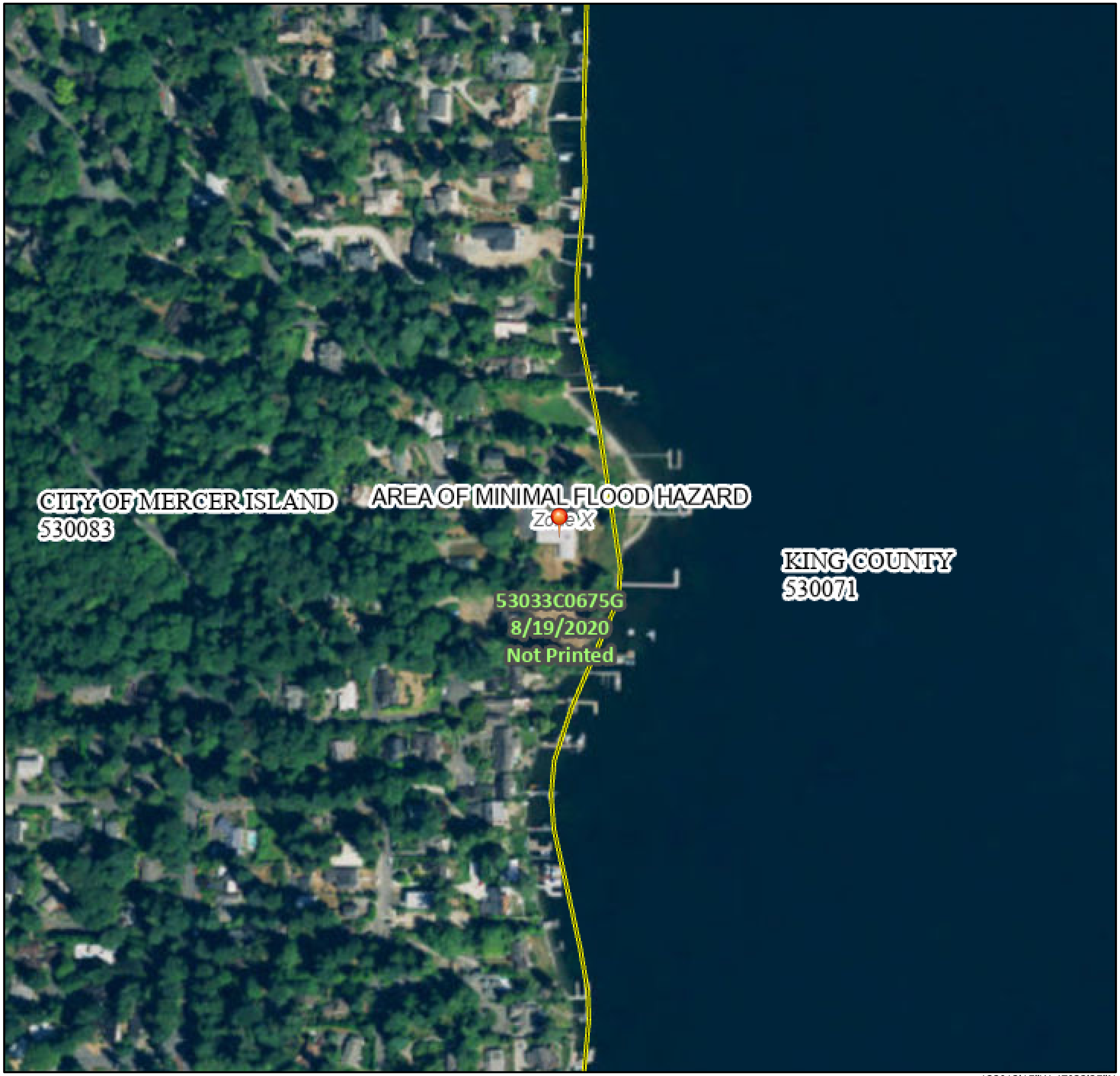
Aerial photography: USDA (2009)

K:\Projects\10-04816-000\Project\lid_feasibility-report-11x17.mxd

# National Flood Hazard Layer FIRMette

FEMA

122°12'52"W 47°32'50"N




122°12'15"W 47°32'25"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

*Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020*

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

**SPECIAL FLOOD HAZARD AREAS**
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

**OTHER AREAS OF FLOOD HAZARD**
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

**OTHER AREAS**
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

**GENERAL STRUCTURES**
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

**OTHER FEATURES**
- B 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

**MAP PANELS**
- Digital Data Available
- No Digital Data Available
- Unmapped

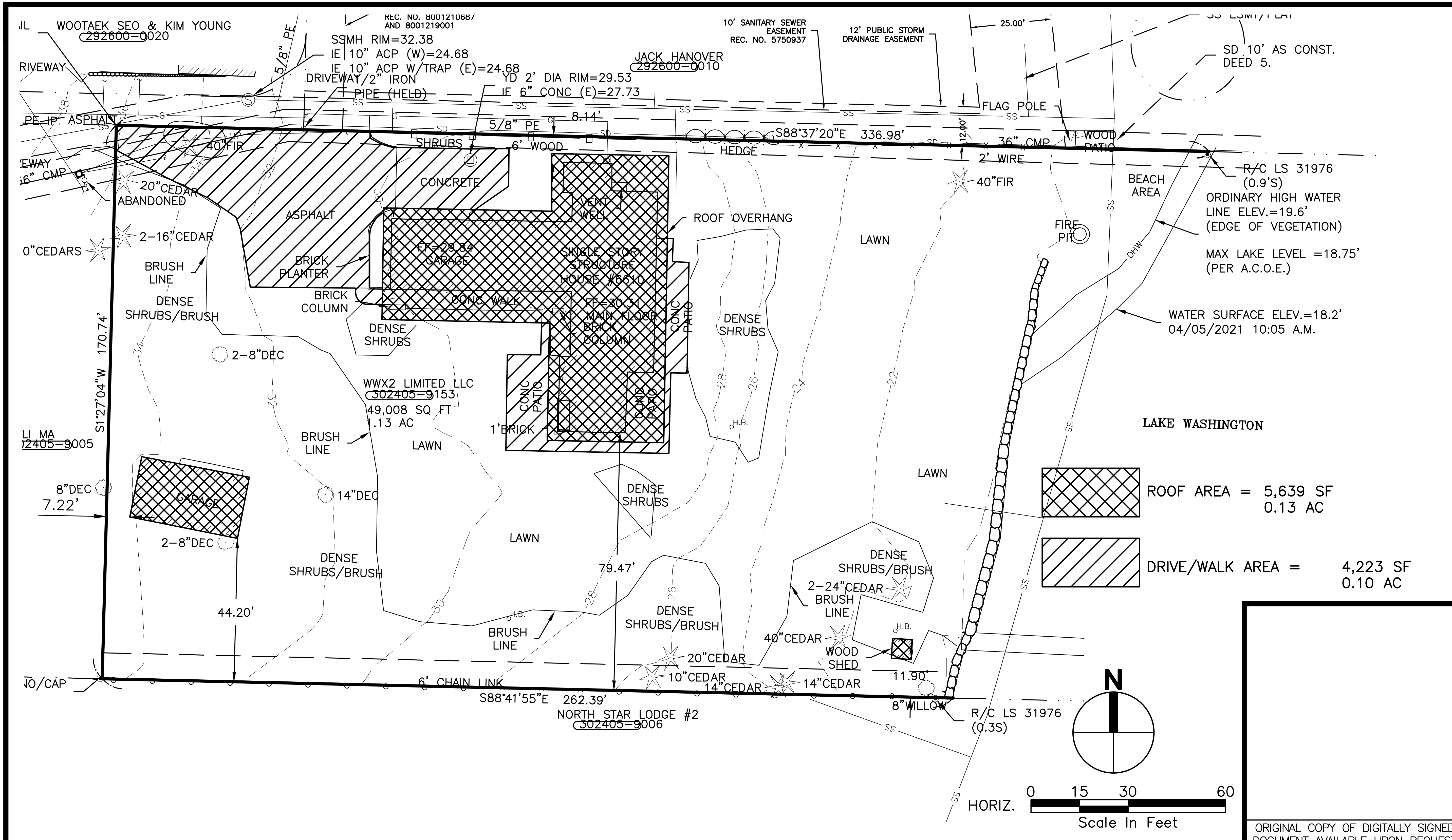
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/27/2021 at 4:11 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

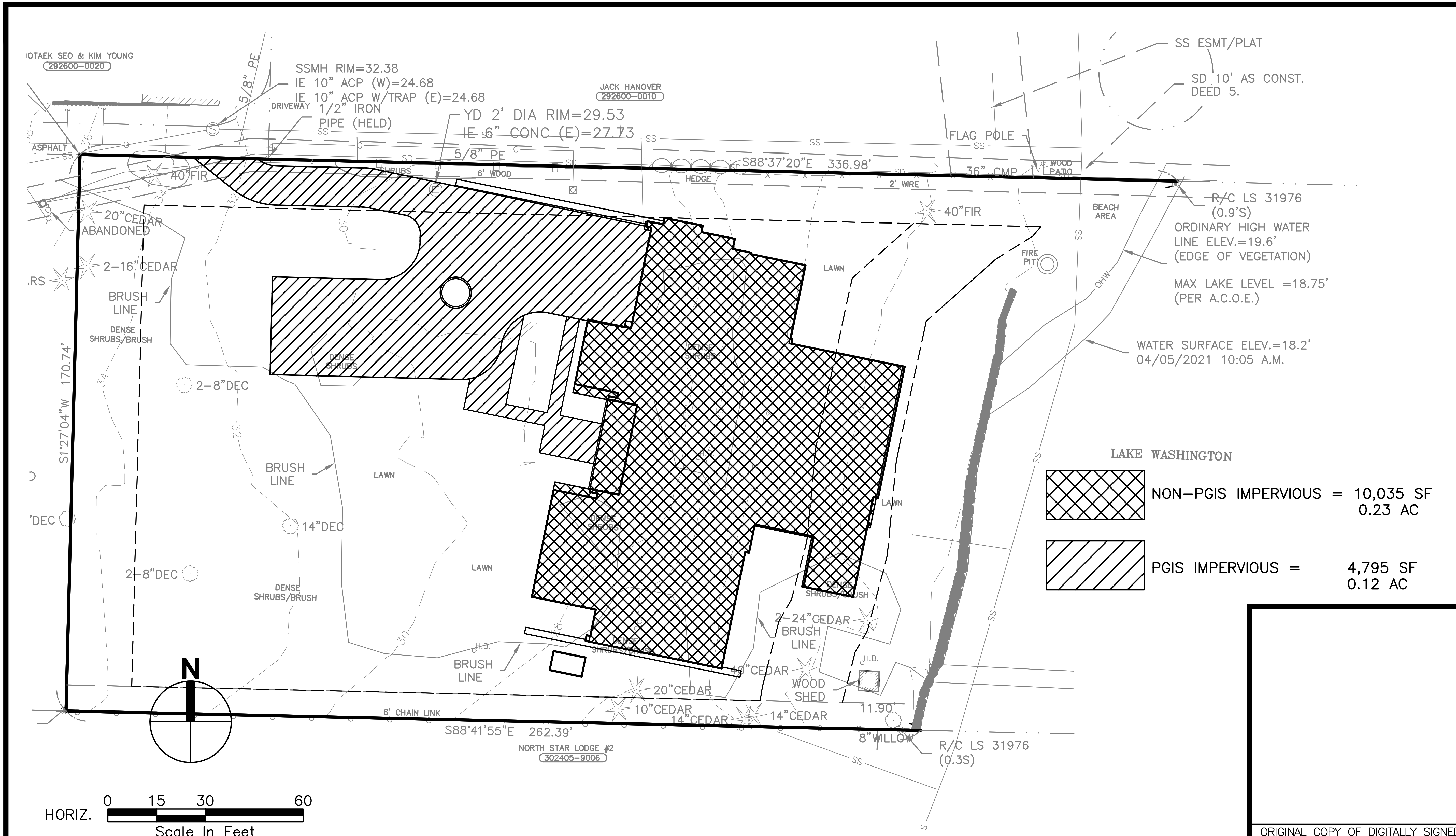
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.




ORIGINAL COPY OF DIGITALLY SIGNED DOCUMENT AVAILABLE UPON REQUEST

FILE NAME: P:\P21\21436 KONERU RESIDENCE\CAD\ENGINEERING\FIGURES\TIR\F21436_SFR_EX-AREAS.DWG
SAVE TIME: 12/21/2021 4:28:24 PM PLOT TIME: 12/21/2021 4:29 PM
USER NAME: CHRISTIAN NICHOLS

| | | | | |
|---|---|---|---|---|
| DESIGNED ______<br>DRAWN ______<br>CHECKED ______ | PACE<br>An Engineering Services Company<br>11255 Kirkland Way, Suite 300<br>Kirkland, WA 98033<br>p. 425.827.2014 \| f. 425.827.5043<br>Civil \| Structural \| Planning \| Survey<br>www. paceengrs.com | DATE<br>DATE<br>SCALE<br>1"=30' | **KONERU SFR**<br>EXISTING IMPERVIOUS AREA EXHIBIT | PACE PROJECT NO.<br>**21436**<br>SHEET NAME<br>SHEET 1 OF 1 |




ORIGINAL COPY OF DIGITALLY SIGNED DOCUMENT AVAILABLE UPON REQUEST

FILE NAME: P:\P21\21436 KONERU RESIDENCE\CAD\ENGINEERING\FIGURES\TIR\F21436_SFR_DEV-AREAS.DWG
SAVE TIME: 12/21/2021 5:39:46 PM PLOT TIME: 12/21/2021 5:41 PM
USER NAME: CHRISTIAN NICHOLS

| | |
|---|---|
| DESIGNED | |
| DRAWN | |
| CHECKED | |

PACE
An Engineering Services Company

11255 Kirkland Way, Suite 300
Kirkland, WA 98033
p. 425.827.2014 | f. 425.827.5043
Civil | Structural | Planning | Survey
www. paceengrs.com

DATE: DATE
SCALE: 1"=30'

**KONERU SFR**

DEVELOPED IMPERVIOUS AREA EXHIBIT

PACE PROJECT NO. **21436**
SHEET NAME
SHEET 1 OF 1

Dheeraj Koneru
Mercer Island, WA

# APPENDIX B
## Reports

*THIS PAGE IS INTENTIONALLY LEFT BLANK.*

GEOTECH
CONSULTANTS, INC.

2401 10th Ave E
Seattle, Washington 98102
(425) 747-5618

June 8, 2021

JN 21151

Dheeraj Koneru
7002 – 93rd Avenue Southeast
Mercer Island, Washington 98040
*via email: dkoneru@gmail.com*

Subject: **Transmittal Letter – Geotechnical Engineering Study and Critical Area Study**
Proposed Property Redevelopment
6610 East Mercer Way
Mercer Island, Washington

Dear Mr. Koneru:

Attached to this transmittal letter is our geotechnical engineering report and Critical Area Study related to geologic hazards for the proposed redevelopment of the property in Mercer Island. The scope of our services consisted of exploring site surface and subsurface conditions, and then developing this report to provide recommendations for general earthwork, stormwater infiltration considerations, and design considerations for foundations, retaining walls, subsurface drainage, and temporary excavations. This work was authorized by your acceptance of our proposal, P-10580, dated March 22, 2021.

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

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

Adam S. Moyer
Geotechnical Engineer

cc: **JMK Homes** – Jed Murphey
*via email: jed@jmkhomes.net*

ASM/MRM:kg

**GEOTECHNICAL ENGINEERING STUDY AND CRITICAL AREA STUDY**
**Proposed Property Redevelopment**
**6610 East Mercer Way**
**Mercer Island, Washington**

This report presents the findings and recommendations of our geotechnical engineering study and Critical Area Study for proposed redevelopment of the subject property in Mercer Island. The scope of the Critical Area Study is intended to satisfy the requirements of section 19.07.110 of the Mercer Island City Code (MICC), which applies to Critical Area Studies.

We were provided with an undated conceptual site plan of the proposed development and a topographic map of the property. The topographic map was developed by PACE and dated April 2021. Based on the conceptual site plan, and conversations with JMK Homes, we understand that the existing residence and detached garage will be demolished, and the property will likely be short-platted into two new parcels. The new, larger, eastern parcel will cover most of the property, while the new smaller western parcel will cover the western approximately 90 feet of the existing subject site. We understand a new two-story residence will be constructed near the center of the new eastern parcel and will have a lowest (first) floor near the existing ground surface. An in-ground swimming pool is proposed east of the residence, which will be surrounded by a pool deck and patio hardscaping. The grade around the pool may be raised by filling so that the bottom of the pool will not have to extend more than a few feet below the existing grade.

A smaller, detached building will be constructed on the new western parcel. While the development is early in the planning stage, we understand this detached building may be a separate residence and/or a detached garage and guest house. The detached residence will likely also be two stories with the lowest (first) floor near the existing grade. A shared driveway and/or motorcourt will be located between the two new buildings. Based on the provided conceptual plans, the proposed new residences will have minimum setbacks of 10 feet from the property lines.

Due to the proximity to Lake Washington and relatively shallow groundwater, we understand excavations for the planned redevelopment will be minimized and the final site grade will generally be kept close to, or above, the existing conditions.

If the scope of the project changes from what we have described above, we should be provided with revised plans in order to determine if modifications to the recommendations and conclusions of this report are warranted.

## ***SITE CONDITIONS***

### *SURFACE*

The Vicinity Map, Plate 1, illustrates the general location of the site near the south-central portion of the eastern perimeter of Mercer Island along Lake Washington. The irregularly-shaped subject site is generally trapezoidal, with a width of 170.7 feet in the north-south direction and a depth of 262 to 337 feet in the east-west direction along its southern and northern property lines, respectively. The property is bordered by Lake Washington to the east, and residential parcels containing single-family residences to the north, west, and south. The subject site is accessed by a shared private driveway that descends from East Mercer Way down to the northwestern corner of the property.

A one-story house constructed in the 1950s is located near the center of the property; the house has a floor elevation of 30.3 feet and is bordered by concrete paver patios and concrete walkways. A concrete and asphalt driveway spans between the attached garage in the northwest corner house to the shared access driveway to the northwest. A small detached garage/shop is located in the southwest corner of the property. Dense brush and shrubs surround the garage/shop and covers the southwest corner of the site, while the remainder of the property is generally covered by a grass lawn with scattered large evergreen trees. A 2- to 3-foot-tall rock bulkhead covers most of the shoreline with Lake Washington along the eastern property line; however, the northern end of the shoreline transitions into a small beach area. A wooden dock extends into Lake Washington off the shore in the southeast corner of the parcel.

The subject site slopes gently downwards from west to east to the shore of Lake Washington. The ground surface has an overall inclination ranging from 3 to 5.5 percent across the property. However, a short, 4-foot-tall moderate slope is located east of the existing house; it is apparent that this short slope was created by placing the soil generated by the house excavation to create the flat patio area along the eastern perimeter of the house.

Residential properties containing single-family residences border the site to the north, west, and south. The western and southern adjacent residences have large setbacks from the subject site. However, there is a small shed/boathouse on the southern neighboring property that is close to the south property line, and near the shore of Lake Washington. The two northern adjacent residences are offset approximately 10 and 20 feet from the shared property line with the subject site.

The City of Mercer Island's GIS tool maps the subject site within several geologic hazard areas. The entirety of the site is mapped within both a seismic hazard area and a potential landslide hazard area. There is also a mapped piped drainage that is buried along the northern property line and exits into Lake Washington to the east.

As discussed above, the subject site is very gently sloped. The western property line is at least 150 feet from the bottom of a steep-sided ravine extending in a northwesterly direction to intersect East Mercer Way. We did not observe any indications of recent slope instability on or around the site during our recent visit to the property. On the Mercer Island Landslide Hazard Map (Troost and Wisher, 2009) there is a marked "identified landslide location" near the location of the subject site. There is also a subaqueous mass wasting deposit extending east of the subject site into Lake Washington. From our observations, it is apparent that the subject site is located on an alluvial fan at the base of the ravine that rises to East Mercer Way. While landslides on the steep sideslopes of the ravine would be expected over time, the ravine itself appears to have been caused by post-glacial runoff, not large-scale slope instability.

## *SUBSURFACE*

The subsurface conditions were explored by drilling five test borings at the approximate locations shown on the Site Exploration Plan, Plate 2. Our exploration program was based on the proposed construction, anticipated subsurface conditions and those encountered during exploration, and the scope of work outlined in our proposal.

The test borings were drilled on April 30, 2021, using a track-mounted hollow-stem auger drill. Samples were taken at approximate 2.5- or 5-foot intervals with a standard penetration sampler. This split-spoon sampler, which has a 2-inch outside diameter, is driven into the soil with a 140-pound hammer falling 30 inches. The number of blows required to advance the sampler a given distance is an indication of the soil density or consistency. A geotechnical engineer from our staff observed the drilling process, logged the test borings, and obtained representative samples of the soil encountered. The Test Boring Logs are attached as Plates 3 through 7.

### ***Soil Conditions***

The subsurface explorations conducted on the site generally encountered loose alluvial soils (soils deposited by moving water such as streams) consisting predominantly of silt with interbedded layers of sand, and silty sands beneath the ground surface. Dense to very dense sand was encountered beneath the loose soils at a depth of 30 feet in Test Borings 1, 2, and 3, on the eastern half of the subject site. Test Borings 4 and 5 were conducted on the western half of the subject site, and encountered medium-dense to dense sand beneath the near-surface alluvial soils at a depth of 20 feet. Medium-dense to dense clayey sand was revealed below 26 to 30 feet, and became very dense below 35 feet.

The dense to very dense soils have been compressed under the weight of glacial ice.

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

### ***Groundwater Conditions***

All of the borings found groundwater below a depth of 5 to 8 feet. The borings were conducted in early summer, when groundwater levels could have started to fall slightly. The previous fall and winter had been very wet. Groundwater levels often fluctuate with rainfall and other factors.

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

## *SEISMIC CONSIDERATIONS*

In accordance with the International Building Code (IBC), the site class within 100 feet of the ground surface is best represented by Site Class Type F (Failure-Prone Site Class). However, the code allows for an exception from the F classification if the building period is less than 0.5 seconds. We anticipate the proposed buildings will be less than 0.5 seconds, and therefore a Site Class Type E can be used for the project. This will need to be confirmed by the project structural engineer. As noted in the USGS website, the mapped spectral acceleration value for a 0.2 second ($S_s$) and 1.0 second period ($S_1$) equals 1.45g and 0.50g, respectively.

The near surface soils beneath the site consisted of saturated silty sand, sand, silt, and peat. These soils have been demonstrated to have a moderate to high potential for liquefaction during a large earthquake. The IBC and ASCE 7 require that the potential for liquefaction (soil strength loss) be evaluated for the peak ground acceleration of the Maximum Considered Earthquake (MCE), which has a probability of occurring once in 2,475 years (2 percent probability of occurring in a 50-year period).

The recommendations presented in this report to support the proposed new structures on deep foundations embedded into the dense to very dense underlying sands not susceptible to seismic liquefaction are intended to prevent catastrophic failure of the proposed new structures in the event of a large seismic event. However, this does not imply the proposed pipe pile-supported structures will be functional and/or safe to inhabit after a large seismic event.

## ***CRITICAL AREAS STUDY (MICC 19.07)***

**Seismic Hazard and Potential Landslide Hazard Areas:** The entire subject site is located within a mapped Seismic Hazard Area and a Potential Landslide Hazard area. Both geologic hazard areas cover much of the general vicinity to the north and south as well. The site is essentially flat and is well set back from any steep slopes. As such, the potential for instability on the site is negligible. The mapping of the Potential Landslide Hazard Area is apparently due to the inference by geologists that the site lies within an ancient landslide. However, we observed no signs of landslide debris in our borings, and the topography in the site vicinity appears more likely to be the result of erosion by large volumes of post-glacial runoff, combined with more recent deposition of alluvial deposits. To our knowledge, no recent large-scale movement has been documented in this area.

The site is located over 150 feet from the steep slopes that occupy the adjacent western property. This setback is more than sufficient to protect the planned development from any future instability on these distant slopes. No additional measures, such as buffers or landslide catchment walls, are needed. The proposed development will not adversely impact the stability of the steep slopes to the west.

The proposed development will be supported on deep foundation embedded into the glacially compressed soils which are not liquefiable, due to their dense nature. This mitigates the Seismic Hazard.

**Buffers and Mitigation:** Under MICC 19.07.160(C), a prescriptive buffer of 25 feet is indicated from all sides of a shallow landslide-hazard area. As noted above, the entire site lies within a mapped Potential Landslide Hazard Area, and the prescriptive buffer would extend far beyond the boundaries of the property and the planned development area. We recognize that the planned development will occur within the designated critical areas. The recommendations presented in this geotechnical report are intended to allow the project to be constructed in the proposed configuration without adverse impacts to critical areas on the site or the neighboring properties. The geotechnical recommendations associated with foundations, shoring, and erosion control will mitigate any potential hazards to critical areas on the site.

**Statement of Risk:** In order to satisfy the City of Mercer Island’s requirements, a statement of risk is needed. As such, we make the following statement:

> *Provided the recommendations in this report are followed, it is our professional opinion that the recommendations presented in this report for the planned alterations will render the development as safe as if it were not located in a geologically hazardous area, and will not adversely impact critical areas on adjacent properties.*

## CONCLUSIONS AND RECOMMENDATIONS

### *GENERAL*

*THIS SECTION CONTAINS A SUMMARY OF OUR STUDY AND FINDINGS FOR THE PURPOSES OF A GENERAL OVERVIEW ONLY. MORE SPECIFIC RECOMMENDATIONS AND CONCLUSIONS ARE CONTAINED IN THE REMAINDER OF THIS REPORT. ANY PARTY RELYING ON THIS REPORT SHOULD READ THE ENTIRE DOCUMENT.*

The test borings conducted for this study encountered loose alluvial soils consisting predominantly of silt with interbedded layers of sand, peat, and silt sand beneath the ground surface across the subject site. Competent dense to very dense sands and clayey sands were revealed below depths of 30 to 35 feet. Conventional shallow foundations constructed on the loose, moderately-compressible, alluvial soils beneath the ground surface would experience significant post-construction settlement as the loose soils consolidate over time. Considering this, we recommend the proposed houses be supported on small-diameter pipe piles driven into the dense to very dense underlying sands. This is a typical foundation system that has been used for homes in the area. We recommend floor slabs and other settlement-sensitive elements, such as decks, patios, entryways, and the proposed pool and surrounding pool deck be supported on driven pipe piles as well to prevent differential settlement between them and the pile-supported residence. The utilities servicing the pool (water pipes, drainlines, etc.) should be hung from the pile-supported pool or pool deck, so that they are not broken or sheared from the pool when the underlying ground settles. It is also prudent to support garage slabs on the piles in order to prevent noticeable settlement relative to the rest of the foundation system.

The depth and elevation of the bottom of the proposed pool relative to the will be an important design consideration. Our test borings encountered groundwater at depths of 5 to 7 feet beneath the ground surface, or approximately at the elevation of Lake Washington. Therefore, it will be important to keep the bottom of the proposed pool above the groundwater table, in order to prevent the need for aggressive dewatering, and possibly shoring, to install the pool. It will be important to provide a pressure relief valve or drainage beneath the pool so that it is not lifted out of the ground when it is drained for maintenance. If the pool shell is cast directly against the surrounding fill and loose native soils, it should be reinforced to withstand relatively heavy lateral soil loads in the eventuality that the pool is drained for maintenance. An effective active earth pressure using a 45 pounds per cubic foot (pcf) equivalent fluid density should be used for design of the walls in the unsupported condition. Finally, as with any other settlement-sensitive on-grade elements, the pool deck surrounding the pool should be built as a reinforced concrete slab spanning between piles.

We understand that the proposed buildings will be constructed near the existing ground surface and will have a minimum setback of 10 feet from the property lines. Therefore, temporary excavations for the buildings and proposed pool are expected to be minimal. Temporary open cut slopes in the onsite soils <u>above the water table</u> should be inclined no steeper than 1:5:1 (Horizontal:Vertical) from top to bottom. It appears excavations for the proposed development will be feasible using open cut slopes within the property. Excavation below the groundwater elevation will require temporary excavation shoring.

Considering the shallow groundwater elevation and the relatively impervious alluvial silt soils encountered underlying the subject site, we recommend an underslab drainage system be installed beneath the lowest finished floor slab of the proposed structures. The ***Drainage Considerations*** section of this report has an expanded discussion of underslab drainage recommendations. If the interior spaces are to be located below the expected groundwater table, they would need to be designed to be watertight and to resist both hydrostatic pressures on walls and floors.

The site soils that will be excavated have a low compacted strength and very poor drainage characteristics. We recommend against reusing the onsite soils for any wall backfill, or structural fill that will support on-grade elements, even the driveway or entryways. As a result, we expect that excavated soils will be hauled off the site, and imported granular well-draining material will be needed for structural fill for the project.

As previously discussed, the test borings encountered loose alluvial soils consisting predominantly of relatively impervious silt beneath the ground surface. Furthermore, groundwater was encountered approximately 5 to 7 feet beneath the below grade. Considering this, it is our opinion that onsite stormwater infiltration or dispersion will not be feasible on the subject site from a geotechnical standpoint.

Projects involving small-diameter pipe piles often include the need for lateral resistance from fill placed against the foundations. If this is the case for this project, it is important that the structural engineer indicate this requirement on the plans for the general and earthwork contractor's information. Compaction requirements for this fill are discussed below in ***Pipe Piles***. The building department may require that we verify suitable compaction of this fill prior to completion of the project.

It is likely that some settlement of the ground surrounding pile-supported buildings will occur over time. In order to reduce the potential problems associated with this, we recommend the following:

- Fill to the desired site grades several months prior to constructing on-grade slabs, walkways, and pavements around the buildings. This allows the underlying soils to undergo some consolidation under the new soil loads before final grading is accomplished.

- Connect all in-ground utilities beneath the floor slabs to the pile-supported floors or grade beams. This is intended to prevent utilities, such as sewers, from being pulled out of the floor as the underlying soils settle away from the slab. Hangers or straps can be poured into the floors and grade beams to carry the piping. The spacing of these supporting elements will depend on the distance that the pipe material can span unsupported.

- Construct all entrance walkways as reinforced slabs that are doweled into the grade beam at the door thresholds. This will allow the walkways to ramp down and away from the building as they settle, without causing a downset at the threshold.

- Isolate on-grade elements, such as walkways or pavements, from pile-supported foundations and columns to allow differential movement.

While the site is not located in a mapped Erosion Hazard area, appropriate temporary erosion control measures will need to be implemented to prevent silty runoff from leaving the property. We have worked on numerous waterfront projects on Mercer Island that have avoided siltation of the lake and surrounding properties by exercising care and being proactive with the maintenance and potential upgrading of the erosion control system through the entire construction process. The location of the site on the shore of Lake Washington will make proper erosion control implementation important to prevent adverse impacts to the lake. The temporary erosion control measures needed during the site development will depend heavily on the weather and groundwater conditions that are encountered during the site work. One of the most important considerations, particularly during wet weather, is to immediately cover any bare soil areas to prevent accumulated water or runoff from the work area from becoming silty in the first place. Silty water cannot be discharged to the lake, so a temporary holding tank should be planned for wet weather earthwork. A wire-backed silt fence bedded in compost, not native soil or sand, should be erected as close as possible to the planned work area, and the existing vegetation between the silt fence and the lake left in place. Typically, if wet weather construction is anticipated, two parallel silt fences should be installed along the shoreline. Rocked construction access and staging areas should be established wherever trucks will have to drive off of pavement, in order reduce the amount of soil or mud carried off the property by trucks and equipment. It will also be important to cap any existing drain lines found running toward the lake until excavation is completed. This will reduce the potential for silty water finding an old pipe and flowing into the lake. Covering the base of the excavation with a layer of clean gravel or rock is also prudent to reduce the amount of mud and silty water generated. Utilities reaching between the house and the lake should not be installed during rainy weather, and any disturbed area caused by the utility installation should be minimized by using small equipment. Cut slopes and soil stockpiles should be covered with plastic during wet weather. Soil stockpiles should be minimized. Following rough grading, it may be necessary to mulch or hydroseed bare areas that will not be immediately covered with landscaping or an impervious surface. Wet weather construction (October 1 through March 31) on this site should be possible without adverse impacts to the surrounding properties. In preventing erosion control problems on any site, it is most important that any disturbed soil areas be immediately protected. This requires diligence and frequent communication on the part of the general contractor and earthwork subcontractor. As with all construction projects undertaken during potentially wet conditions, it is important that the contractor's on-site personnel are familiar with erosion control measures and that they monitor their performance on a regular basis. It is also appropriate for them to take immediate action to correct any erosion control problems that may develop, without waiting for input from the geotechnical engineer or representatives of the City.

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

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

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

***PIPE PILES***

Four-, or 6-inch-diameter pipe piles driven with 1,100-, 2,000-pound, or 3,000-pound hydraulic jackhammer to the following final penetration rates may be assigned the following compressive capacities.

| INSIDE PILE DIAMETER | FINAL DRIVING RATE (1,100-pound hammer) | FINAL DRIVING RATE (2,000-pound hammer) | FINAL DRIVING RATE (3,000-pound hammer) | ALLOWABLE COMPRESSIVE CAPACITY |
|---|---|---|---|---|
| 4 inches | 10 sec/inch | 4 sec/inch | n/a | 10 tons |
| 6 inches | 20 sec/inch | 10 sec/inch | 6 sec/inch | 15 tons |

**Note:** The refusal criteria indicated in the above table are valid only for pipe piles that are installed using a hydraulic impact hammer carried on leads that allow the hammer to sit on the top of the pile during driving. If the piles are installed by alternative methods, such as a vibratory hammer or a hammer that is hard-mounted to the installation machine, numerous load tests to 200 percent of the design capacity would be necessary to substantiate the allowable pile load. The appropriate number of load tests would need to be determined at the time the contractor and installation method are chosen.

As a minimum, Schedule 40 pipe should be used. Organic peat soils were encountered beneath the subject site; therefore, due to an elevated corrosion potential, it is our opinion that corrosion protection, such as galvanizing, be used on the pipe piles.

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

Pile caps and grade beams should be used to transmit loads to the piles. Isolated pile caps should include a minimum of two piles to reduce the potential for eccentric loads being applied to the piles. Subsequent sections of pipe can be connected with slip or threaded couplers, or they can be welded together. If slip couplers are used, they should fit snugly into the pipe sections. This may require that shims be used or that beads of welding flux be applied to the outside of the coupler.

Lateral loads due to wind or seismic forces may be resisted by passive earth pressure acting on the vertical, embedded portions of the foundation. For this condition, the foundation must be either poured directly against relatively level, undisturbed soil or be surrounded by level compacted fill. We recommend using an ultimate (no safety factor included) passive earth pressure of 300 pounds per cubic foot (pcf) for this resistance. If the ground in front of a foundation is loose or sloping, the passive earth pressure given above will not be appropriate. Compacted fill placed against the foundations can consist of imported soil that is tamped into place using the backhoe or is compacted using a jumping jack compactor. It is necessary for the fill to be compacted to a firm condition, but it does not need to reach even 90 percent relative compaction to develop the passive resistance recommended above.

***FOUNDATION AND RETAINING WALLS***

No significant retaining walls are expected for this project, and walls taller than a few feet should be avoided. Retaining walls backfilled on only one side should be designed to resist the lateral earth pressures imposed by the soil they retain. The following recommended parameters are for walls that restrain level backfill:

| PARAMETER | VALUE |
|---|---|
| Active Earth Pressure * | 45 pcf |
| Passive Earth Pressure | 300 pcf |
| Soil Unit Weight | 130 pcf |

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

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

The design values given above do not include the effects of any hydrostatic pressures behind the walls and assume that no surcharges, such as those caused by slopes, vehicles, or adjacent foundations will be exerted on the walls. If these conditions exist, those pressures should be added to the above lateral soil pressures. The existing site retaining wall north of the proposed residence and covered walkway will likely place a surcharge onto the proposed structures' northern foundation walls. We can provide appropriate surcharge loads once more detailed plans have been developed. It may be possible for the excavation shoring to be designed to withstand this surcharge. Where sloping backfill is desired behind the walls, we will need to be given the wall dimensions and the slope of the backfill in order to provide the appropriate design earth pressures. The surcharge due to traffic loads behind a wall can typically be accounted for by adding a uniform pressure equal to 2 feet multiplied by the above active fluid density. Heavy construction equipment should not be operated behind retaining and foundation walls within a distance equal to the height of a wall, unless the walls are designed for the additional lateral pressures resulting from the equipment.

The values given above are to be used to design only permanent foundation and retaining walls that are to be backfilled, such as conventional walls constructed of reinforced concrete or masonry. It is not appropriate to use the above earth pressures and soil unit weight to back-calculate soil strength parameters for design of other types of retaining walls, such as soldier pile, reinforced earth, modular or soil nail walls. We can assist with design of these types of walls, if desired.

The passive pressure given is appropriate only for a shear key poured directly against undisturbed native soil, or for the depth of level, well-compacted fill placed in front of a retaining or foundation wall. The values for friction and passive resistance are ultimate values and do not include a safety factor. Restrained wall soil parameters should be utilized the wall and reinforcing design for a distance of 1.5 times the wall height from corners or bends in the walls, or from other points of restraint. This is intended to reduce the amount of cracking that can occur where a wall is restrained by a corner.

### ***Wall Pressures Due to Seismic Forces***

The surcharge wall loads that could be imposed by the design earthquake can be modeled by adding a uniform lateral pressure to the above-recommended active pressure. The recommended surcharge pressure is 8**H** pounds per square foot (psf), where **H** is the design retention height of the wall. Using this increased pressure, the safety factor against sliding and overturning can be reduced to 1.2 for the seismic analysis.

***Retaining Wall Backfill and Waterproofing***

Backfill placed behind retaining or foundation walls should be coarse, free-draining structural fill containing no organics. This backfill should contain no more than 5 percent silt or clay particles and have no gravel greater than 4 inches in diameter. The percentage of particles passing the No. 4 sieve should be between 25 and 70 percent. The on-site soils are not free-draining, and should not be reused as wall backfill.

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

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

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

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

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

## *FLOOR SLABS*

As discussed in the ***General*** section, we recommend the proposed residences and garage slabs be constructed with structural slabs spanning between the pipe pile supported foundations, or with framed floors over crawlspaces.

Due to the relatively shallow groundwater encountered beneath the site, we recommend an underslab drainage system be installed beneath the lowest finished floor. An expanded discussion on underslab drainage is presented in the ***Drainage Considerations*** section of this report.

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

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

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

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

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

***DRAINAGE CONSIDERATIONS***

Footing drains should be used where: (1) crawl spaces or basements will be below a structure; (2) a slab is below the outside grade; or, (3) the outside grade does not slope downward from a building. Drains should also be placed at the base of all earth-retaining walls. These drains should be surrounded by at least 6 inches of 1-inch-minus, washed rock that is encircled with non-woven, geotextile filter fabric (Mirafi 140N, Supac 4NP, or similar material). At its highest point, a perforated pipe invert should be at least 6 inches below the bottom of a slab floor or the level of a crawl space. The discharge pipe for subsurface drains should be sloped for flow to the outlet point. Roof and surface water drains must not discharge into the foundation drain system. A typical footing drain detail is attached to this report as Plate 8. For the best long-term performance, perforated PVC pipe is recommended for all subsurface drains. Clean-outs should be provided for potential future flushing or cleaning of footing drains.

As discussed in the ***General*** section, we recommend an underslab drainage system be installed beneath the lowest finished floors. This system should consist of at least 9 inches of clean gravel or rock beneath the entire slab footprint. Perforated, 4-inch-diameter, PVC pipe should be embedded in the gravel/rock layer at 15- to 20-foot spacing and the gravel layer and piping should then be covered with a vapor retarder/barrier. The perforated pipe can be laid essentially level and at the same elevation as the perimeter footing drains. However, a solid outlet pipe should be sloped for gravity drainage to an approved discharge point. A typical underslab drainage detail is attached to this report as Plate 9.

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

Shallow groundwater was observed during our field work. As discussed above, excavations below the water table would require extensive dewatering and shoring. Even temporary dewatering could cause ground settlement on adjacent properties, if the drawdown influence zone from the dewatering extends outside of the property boundaries.

Final site grading in areas adjacent to a building should slope away at least one to 2 percent, except where the area is paved. Surface drains should be provided where necessary to prevent ponding of water behind foundation or retaining walls. A discussion of grading and drainage related to pervious surfaces near walls and structures is contained in the ***Foundation and Retaining Walls*** section.

***GENERAL EARTHWORK AND STRUCTURAL FILL***

All building and pavement areas should be stripped of surface vegetation, topsoil, organic soil, and other deleterious material. The stripped or removed materials should not be mixed with any materials to be used as structural fill, but they could be used in non-structural areas, such as landscape beds.

Structural fill is defined as any fill, including utility backfill, placed under, or close to, a building, or in other areas where the underlying soil needs to support loads. All structural fill should be placed in horizontal lifts with a moisture content at, or near, the optimum moisture content. The optimum moisture content is that moisture content that results in the greatest compacted dry density. The moisture content of fill is very important and must be closely controlled during the filling and compaction process. As discussed in the ***General*** section, the on-site soils are not suitable for reuse as structural fill, due to their high fines content and moisture sensitivity.

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

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

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

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

## ***LIMITATIONS***

The conclusions and recommendations contained in this report are based on site conditions as they existed at the time of our exploration and assume that the soil and groundwater conditions encountered in the subsurface explorations are representative of subsurface conditions on the site. If the subsurface conditions encountered during construction are significantly different from those observed in our explorations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. Unanticipated conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking samples in test borings. Subsurface conditions can also vary between exploration locations. Such unexpected conditions frequently require making additional expenditures to attain a properly constructed project. It is recommended that the owner consider providing a contingency fund to accommodate such potential extra costs and risks. This is a standard recommendation for all projects.

This report has been prepared for the exclusive use of Dheeraj Koneru and his representatives, for specific application to this project and site. Our conclusions and recommendations are professional opinions derived in accordance with our understanding of current local standards of practice, and within the scope of our services. No warranty is expressed or implied. The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. Our services also do not include assessing or minimizing the potential for biological hazards, such as mold, bacteria, mildew and fungi in either the existing or proposed site development.

## ***ADDITIONAL SERVICES***

In addition to reviewing the final plans, Geotech Consultants, Inc. should be retained to provide geotechnical consultation, testing, and observation services during construction. This is to confirm that subsurface conditions are consistent with those indicated by our exploration, to evaluate whether earthwork and foundation construction activities comply with the general intent of the recommendations presented in this report, and to provide suggestions for design changes in the event subsurface conditions differ from those anticipated prior to the start of construction. However, our work would not include the supervision or direction of the actual work of the contractor and its employees or agents. Also, job and site safety, and dimensional measurements, will be the responsibility of the contractor.

During the construction phase, we will provide geotechnical observation and testing services when requested by you or your representatives. Please be aware that we can only document site work we actually observe. It is still the responsibility of your contractor or on-site construction team to verify that our recommendations are being followed, whether we are present at the site or not.

The following plates are attached to complete this report:

| | |
|---|---|
| Plate 1 | Vicinity Map |
| Plate 2 | Site Exploration Plan |
| Plates 3 - 7 | Test Boring Logs |
| Plate 8 | Typical Footing Drain Detail |
| Plate 9 | Typical Underslab Drain Detail |

We appreciate the opportunity to be of service on this project. Please contact us if you have any questions, or if we can be of further assistance.

Respectfully submitted,

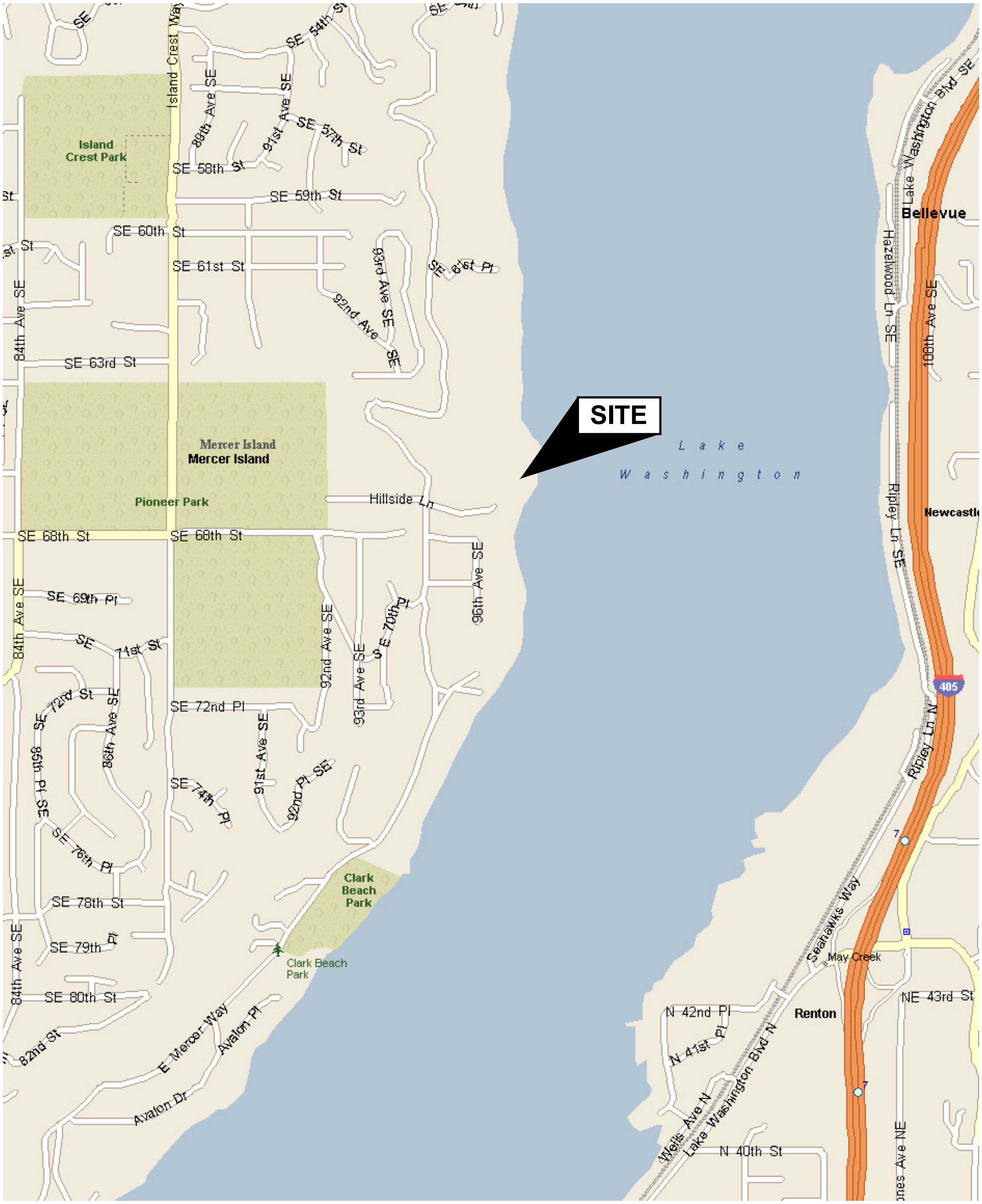
GEOTECH CONSULTANTS, INC.

Adam S. Moyer
Geotechnical Engineer

06/08/2021
Marc R. McGinnis, P.E.
Principal

ASM/MRM:kg

NORTH




*(Source: Microsoft MapPoint, 2013)*

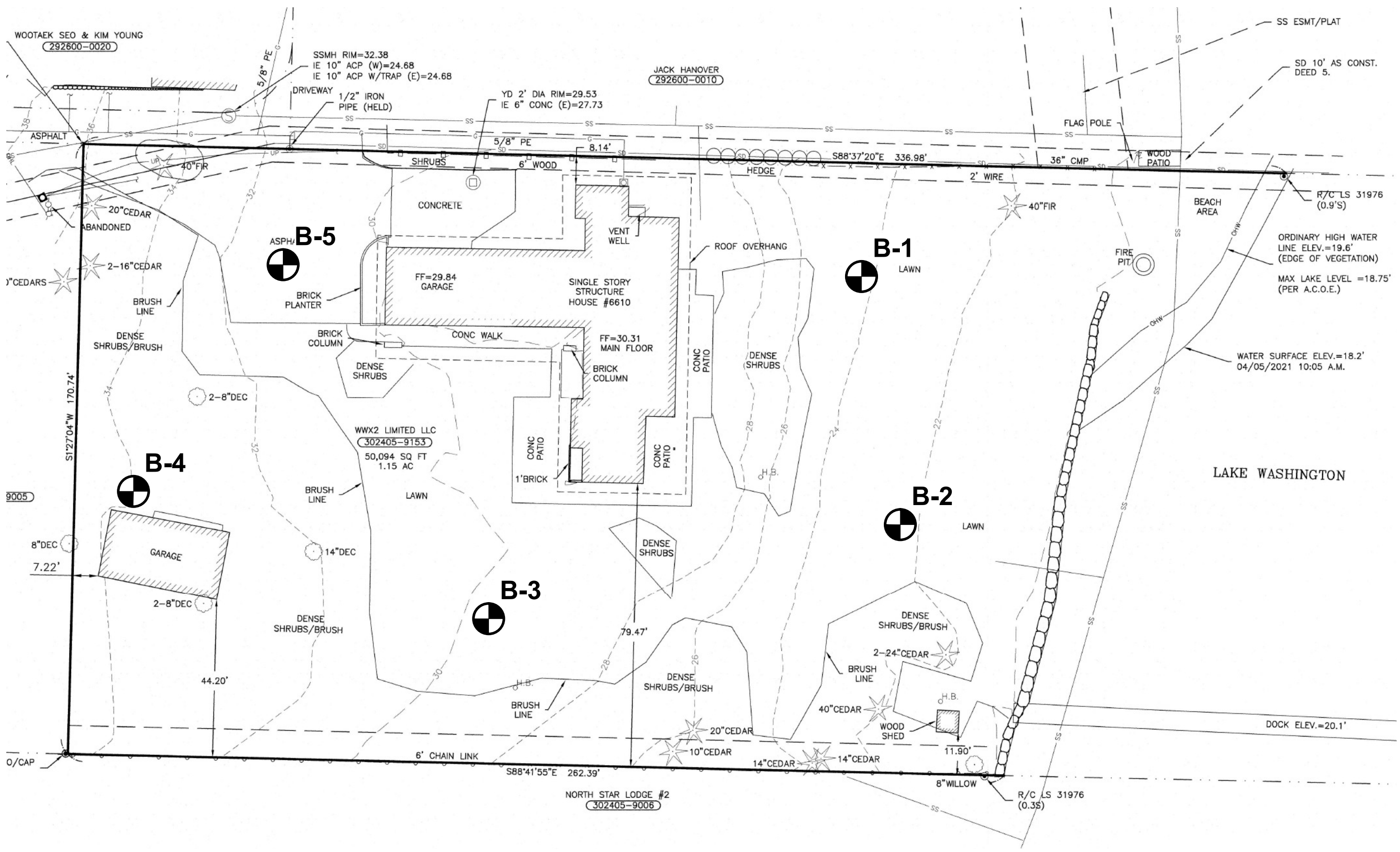
**GEOTECH**
**CONSULTANTS, INC.**

# VICINITY MAP

6610 East Mercer Way
Mercer Island, Washington

| Job No: | Date: | | Plate: |
|---|---|---|---|
| 21151 | June 2021 | | 1 |

NORTH




**Legend:**

Test Boring Location

GEOTECH
CONSULTANTS, INC.

# SITE EXPLORATION PLAN

6610 East Mercer Way
Mercer Island, Washington

| Job No: | Date: | | Plate: |
|---|---|---|---|
| 21151 | June 2021 | No Scale | 2 |

# BORING 1

| Depth (ft) | Water Table | Blows per Foot | Sample | USCS | Description |
|---|---|---|---|---|---|
| 0 | | | | ML | Gray and brown SILT with sand interbeds, non-plastic, very moist, very loose |
| 3 | | 2 | 1 | | |
| 5 | ▼ | 1 | 2 | | -with occasional roots, becomes gray, wet |
| 8 | | 3 | 3 | | -with occasional sand seams |
| 9.5 | | | | SP | Gray SAND, fine- to medium-grained, wet, loose |
| 10.5 | | 2 | 4 | | |
| 11 | | | | PT | Dark-brown PEAT, wet, loose |
| 13 | | | | SM / ML | Gray very silty SAND / sandy SILT with occasional organics, fine- to medium-grained, very moist to wet, loose |
| 15.5 | | 8 | 5 | | |
| 20.5 | | 3 | 6 | | |
| 25.5 | | 3 | 7 | | |
| 26 | | | | SW | Brown SAND with gravel, fine- to coarse-grained, wet, loose |
| 30 | | | | | -becomes dense |
| 30.5 | | 36 | 8 | | |

*** Test boring was terminated at 31.5 feet due to heave on April 30, 2021.**
*** Groundwater seepage was encountered below 5 feet during drilling.**

GEOTECH CONSULTANTS, INC.

**BORING LOG**
6610 East Mercer Way
Mercer Way, Washington

| *Job No:* | *Date:* | *Logged by:* | *Plate:* |
|---|---|---|---|
| 21151 | June 2021 | ASM | 3 |

# BORING 2

| Moisture | Water Table | Blows per Foot | Sample | USCS | Description |
|---|---|---|---|---|---|
| | | | | ML | Gray-brown SILT with occasional sand seams and decomposed organics, non-plastic, very moist, loose |
| | ▼ | 3 | 1 | | |
| | | | | | -becomes gray, slightly plastic, wet, soft |
| | | 3 | 2 | | |
| | | | | | -with gravelly silty SAND seam |
| | | 11 | 3 | | |
| | | | | SM | Blue-gray gravelly silty SAND, fine- to medium-grained, wet, loose to medium-dense |
| | | | | | -becomes gravelly |
| | | 26 | 4 | | |
| | | | | ML | Brown sandy SILT, slightly plastic, very moist to wet, soft to medium-stiff |
| | | | | SP | Gray-brown SAND with gravel, fine- to coarse-grained, wet, loose |
| | | 13 | 5 | | |
| | | | | ML | Brown sandy SILT with sand seams and trace organics, non-plastic, very moist to wet, loose to medium-dense |
| | | 70 | 6 | SP | Brown SAND, medium-grained, wet, very dense |

Depth scale (feet): 5, 10, 15, 20, 25, 30, 35, 40

*** Test boring was terminated at 31.5 feet due to heave on April 30, 2021.**
*** Groundwater seepage was encountered below 7 feet during drilling.**

GEOTECH CONSULTANTS, INC.

## BORING LOG

6610 East Mercer Way
Mercer Way, Washington

| Job No: | Date: | Logged by: | Plate: |
|---|---|---|---|
| 21151 | June 2021 | ASM | 4 |

# BORING 3

| Depth (ft) | Moisture | Water Table | Blows per Foot | Sample | USCS | Description |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Gray-brown with rust mottling, SILT with occasional sand seams and organics, slightly plastic, very moist, soft |
| 5 | | ▼ | 2 | 1 | | |
| 10 | | | 6 | 2 | | -becomes gray, wet |
| 13 | | | | | SM/ML | Gray sandy SILT / very silty SAND with trace gravel, fine- to medium-grained, wet, loose |
| 15 | | | 3 | 3 | | |
| 20 | | | 3 | 4 | | |
| 25 | | | 3 | 5 | | |
| 30 | | | 70 | 6 | SP | Gray-brown SAND, fine- to medium-grained, wet, very dense |
| | | | 92/8" | 7 | | -becomes gravelly |

*** Test boring was terminated at 33 feet due to heave on April 30, 2021.**
*** Groundwater seepage was encountered below 5 feet during drilling.**

GEOTECH CONSULTANTS, INC.

**BORING LOG**
6610 East Mercer Way
Mercer Way, Washington

| Job No: | Date: | Logged by: | Plate: |
|---|---|---|---|
| 21151 | June 2021 | ASM | 5 |

# BORING 4

| Depth (ft) | Moisture | Water Table | Blows per Foot | Sample | USCS | Description |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Brown sandy SILT with occasional sand seams, non-plastic, very moist, loose |
| 5 | | | 2 | 1 | | |
| ~7 | | ▼ | | | | |
| 10 | | | 7 | 2 | | -becomes gray, wet, with occasional pockets of organics |
| 15 | | | 5 | 3 | | -with trace gravel |
| ~18 | | | | | SW | Gray gravelly SAND with trace silt, fine- to coarse-grained, wet, medium-dense |
| 20 | | | **48 | 4 | | |
| 25 | | | 23 | 5 | | -becomes fine-grained, with occasional gravel |
| 30 | | | 24 | 6 | SM | Gray clayey SAND with gravel and sand seams, fine- to medium-grained, wet, medium-dense to dense |
| 35 | | | 49 | 7 | | |
| | | | 27 | 8 | | |

*** Test boring was terminated at 38 feet due to heave on April 30, 2021.**
*** Groundwater seepage was encountered below 7 feet during drilling.**
**** Overstated blow counts due to driving on gravels.**

GEOTECH
CONSULTANTS, INC.

**BORING LOG**
6610 East Mercer Way
Mercer Way, Washington

| Job No: | Date: | Logged by: | Plate: |
|---|---|---|---|
| 21151 | June 2021 | ASM | 6 |

# BORING 5

Depth scale (feet): 5, 10, 15, 20, 25, 30, 35, 40

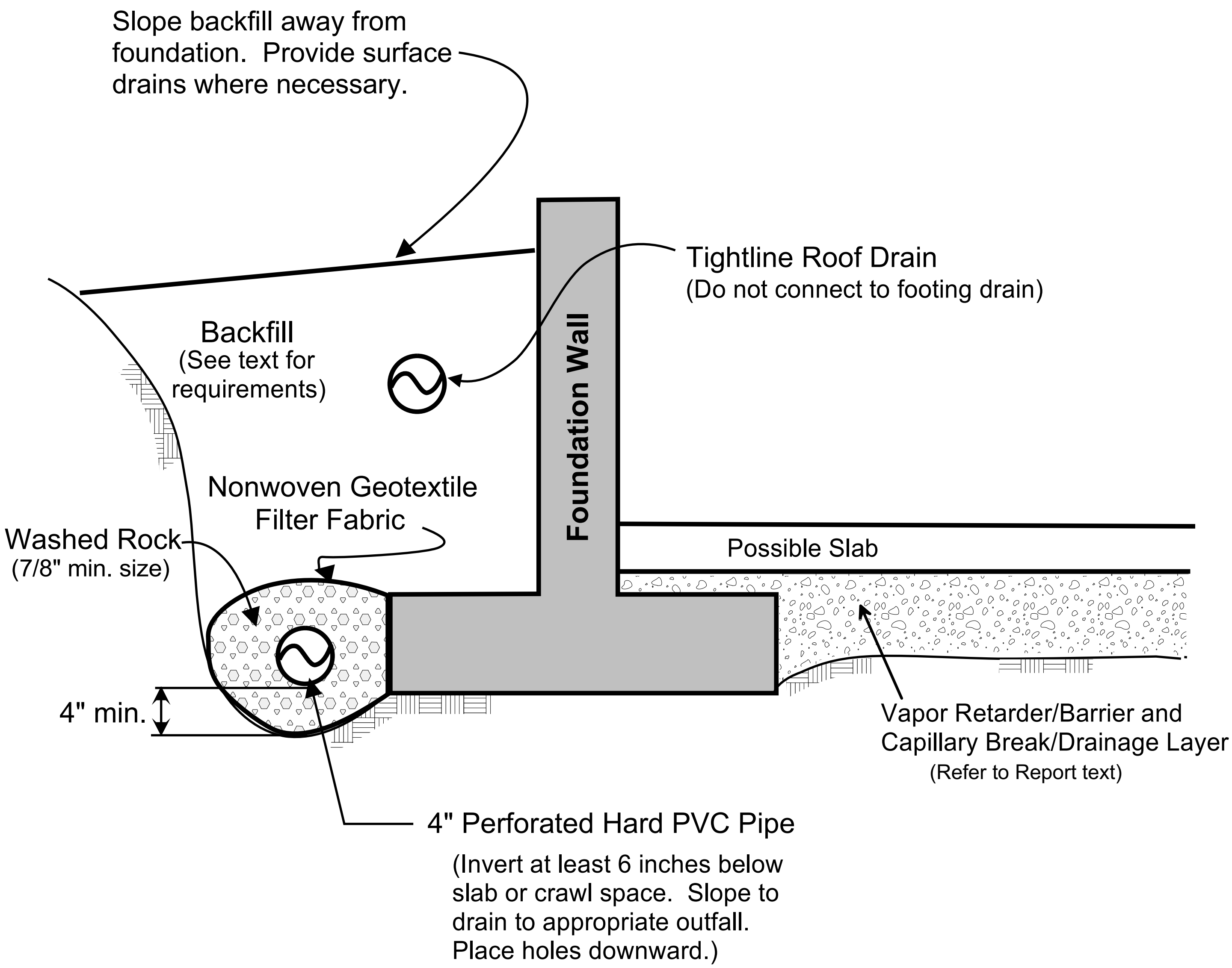
| Moisture | Water Table | Blows per Foot | Sample | USCS | Description |
|---|---|---|---|---|---|
| | | | | | Brown sandy SILT with occasional sand seams and decomposed wood, non-plastic, fine-grained, very moist to wet, loose |
| | | 1 | 1 | ML | |
| | | 3 | 2 | | |
| | | | | | Brown SAND with silt and gravel, fine- to medium-grained, wet, loose to medium-dense |
| | | **24 | 3 | | |
| | | 11 | 4 | SP | |
| | | 20 | 5 | | -with iron oxide stains and occasional thin silt seams, becomes medium-dense |
| | | 29 | 6 | | |
| | | | | | Brown gravelly, slightly clayey SAND, fine- to medium-grained, wet, medium-dense to dense |
| | | | | | -with occasional sand seams |
| | | 29 | 7 | SM/SP | |
| | | 46 | 8 | | -becomes dense to very dense |

*** Test boring was terminated at 36.5 feet due to heave on April 30, 2021.**
*** Groundwater seepage was encountered below 7 feet during drilling.**
**** Overstated blow counts due to driving on gravels.**

GEOTECH CONSULTANTS, INC.

**BORING LOG**
6610 East Mercer Way
Mercer Way, Washington

| Job No: | Date: | Logged by: | Plate: |
|---|---|---|---|
| 21151 | June 2021 | ASM | 7 |




**NOTES:**

(1) In crawl spaces, provide an outlet drain to prevent buildup of water that bypasses the perimeter footing drains.

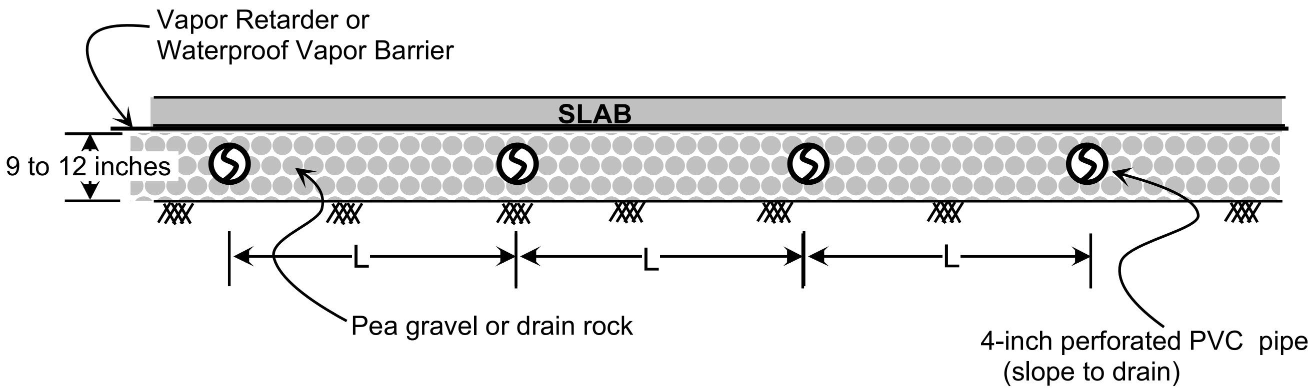
(2) Refer to report text for additional drainage, waterproofing, and slab considerations.

GEOTECH CONSULTANTS, INC.

**FOOTING DRAIN DETAIL**

6610 East Mercer Way
Mercer Island, Washington

| Job No: | Date: | | Plate: |
|---|---|---|---|
| 21151 | June 2021 | | 8 |




**NOTES:**

(1) Refer to the report text for additional drainage and waterproofing considerations.
(2) The typical maximum underslab drain separation (L) is 15 to 20 feet.
(3) No filter fabric is necessary beneath the pipes as long as a minimum thickness of 4 inches of rock is maintained beneath the pipes.
(4) The underslab drains and foundation drains should discharge to a suitable outfall.

GEOTECH
CONSULTANTS, INC.

**TYPICAL UNDERSLAB DRAINAGE**

6610 East Mercer Way
Mercer Island, Washington

| Job No: | Date: | | Plate: |
|---|---|---|---|
| 21151 | June 2021 | | 9 |

**GEOTECH**
**CONSULTANTS, INC.**

2401 10th Ave E
Seattle, Washington 98102
(425) 747-5618

August 24, 2021

JN 21151

Dheeraj Koneru
7002 – 93rd Avenue Southwest
Mercer Island, Washington 98040
*via email: dkoneru@gmail.com*

Subject: **Geotechnical Feasibility of Watercourse Restoration**
Proposed Property Redevelopment
6610 East Mercer Way
Mercer Island, Washington

Greetings:

We have been requested to assess the geotechnical feasibility of removing the culvert and restoring the watercourse that currently crosses the northwestern corner of the site. Based on the provided information, a 3-foot-diameter corrugated metal culvert crosses the northwest corner of the property beneath the driveway and several sizable trees. The culvert extends onto the site from beneath the western neighbor's driveway. The portion of this culvert located within he property boundaries is only approximately 30 feet in length, and it then continues onto the adjacent northern lot extending to Lake Washington to the east.

From a geotechnical perspective, removing the on-site portion of the culvert and restoring the watercourse with an open channel is infeasible for the following reasons:

1. The alluvial soils encountered in our borings beneath the entire site are fine-grained and have a very low strength. As a result, the sideslopes of an open channel would have to be inclined at 3:1 (Horizontal:Vertical) for stability and scour protection. Assuming the channel would have to be 3 to 4 feet in depth, the total channel width would then be at least 18 to 24 feet in width. This is impossible without removing: 1) the existing driveway, and 2) the trees growing over the culvert. It would likely then be necessary then to build a bridge across the open channel to restore access to the site.
2. The necessary broad channel width extends onto the northern neighbor's property and impacts their driveway. Additionally, it could endanger existing utilities, such as the sewer and gas line located to the north of the existing culvert.
3. The short section of restored channel would be highly susceptible to erosion, due to the fine-grained, low strength of the alluvial soils. Erosion of the channel bottom would occur over time, and this would carry sediment to Lake Washington. Also, the erosion of the channel could undermine the integrity of the inlet structure and culvert on the northern property, which could easily migrate to causing sinkholes alongside the neighbor's house.
4. The earthwork associated with restoring this short section of watercourse would cause siltation of Lake Washington, regardless of the temporary erosion control measures taken.
5. The culvert would have to remain as-is on the adjacent western and northern properties. This would require the installation of a tailwater structure at downstream end of the western property line and an inlet structure at upstream end of the culver at the north property line. The loose alluvial soils would not be stable in temporary cuts to construct these structures, requiring the use of temporary shoring, such as driven wide-flange beams.

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

Respectfully submitted,

GEOTECH CONSULTANTS, INC.


08/24/2021

Marc R. McGinnis, P.E.
Principal

cc: **JMK Homes** – Jed Murphey
*via email: jed@jmkhomes.net*

MRM:kg

# Arborist Report

## ~ Pre-construction Tree Inventory ~

**Client**
Dheeraj Koneru
7002 93rd Ave SE
Mercer Island, WA 98040

cc: Jed Murphey, JMK Homes LLC

**Consultant**
Craig Bachmann, Tree133 LLC
Certified Arborist # RM-7652AT
ISA Qualified Tree Risk Assessor
206-475-1924 (direct)
craig@tree133.com

March 1, 2021

To Whom it May Concern:

Tree133 LLC was hired to prepare a pre-construction inventory of trees at 6610 East Mercer Way, Mercer Island, WA. A site visit was performed on the afternoon of Monday, March 1.

This report presents my findings. Please review Assumptions & Limitations at end of report.

### Scope of Work

The purpose of this project was to provide the client(s) with an accurate inventory of regulated trees within and overhanging a residential site. Per Mercer Island City Code (MICC), this includes all trees 10 inches diameter (dsh) and larger.

All trees were measured using industry standard methods. Single-stem trees were measured at 4.5 feet above grade (dsh, diameter at standard height). Trees with unions/swelling that interfere with measurement were measured at the narrowest point below 4.5 feet. Multi-stem trees were measured using “square root of the sum of the squares” method.

Tree numbers and locations are identified on the site map included with this report. As the property is not currently owned by Mr. Koneru, tree identification tags were not installed.

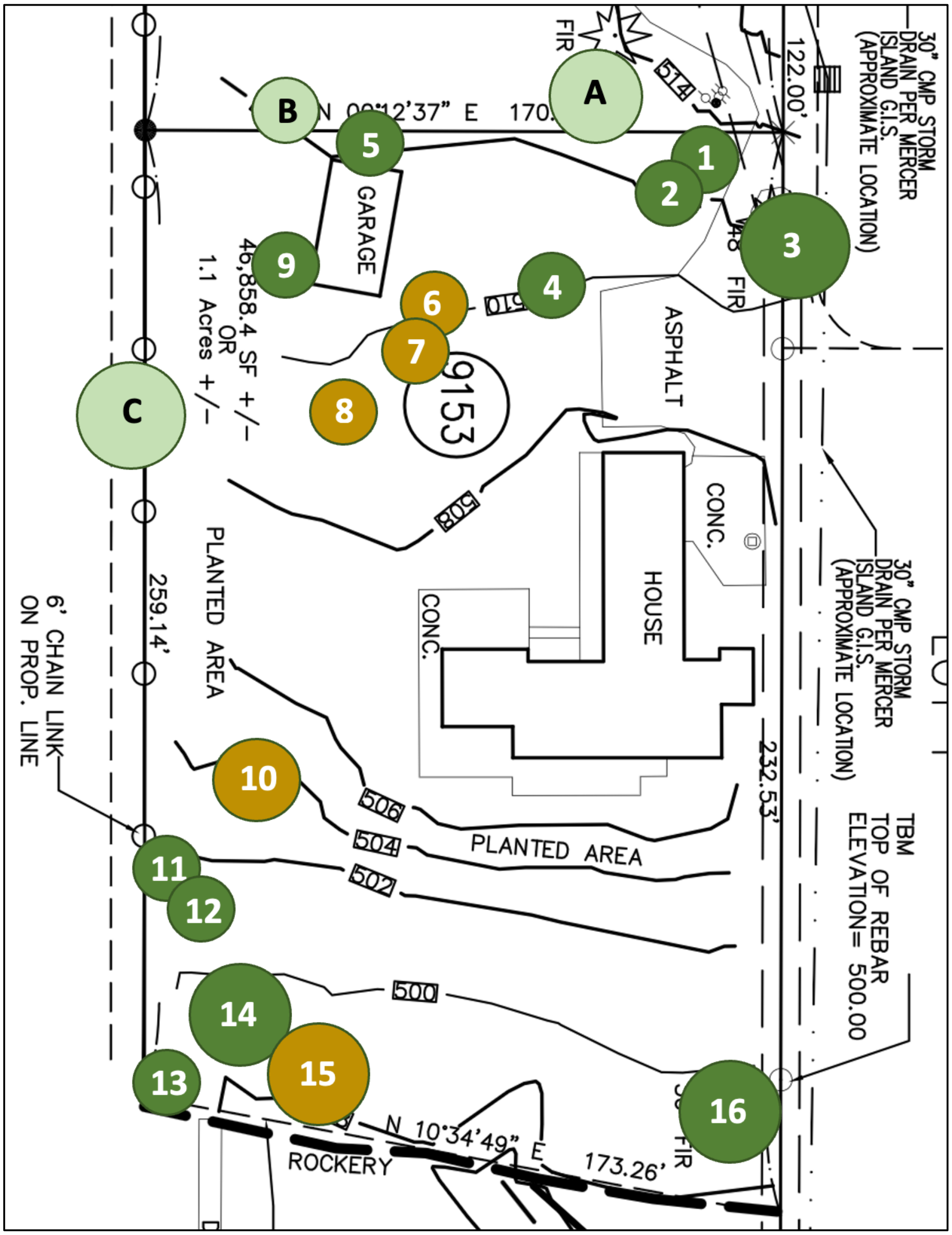
This inventory collected limited data for each tree, including species, diameter (dsh), health/condition and protection status. Based on this data, each tree was evaluated to determine whether it qualified as Exceptional, according to the definition and data table in MICC 19.16.010 (Definitions: Tree, Exceptional).

Based on my brief inspection of each tree during the inventory process, I have identified whether it appears to be suitable for retention during/after redevelopment of the property.

Please note, this inventory does not constitute a tree risk assessment.

## Site Map

The image below identifies the location of all trees included in this inventory. Tree location(s) and canopy size(s) are not to scale and for reference only.




**Key**

- Dark green circles with numbers represent live trees within the site boundaries
- Brown circles with numbers identify dead or girdled/de-barked trees within site boundaries
- Light green circles with alpha characters identify trees overhanging from adjacent properties

## Inventory Findings

Per the scope of work, Tree133 completed an inventory of trees within and overhanging the site and identified the following:

| Tree # | *Species* | Common Name | dsh (in) | Excep-tional | Suitable to Retain | Condition |
|---|---|---|---|---|---|---|
| 1 | *Thuja plicata* | Western red cedar | 23.4 | No | Yes | Generally good condition, asymmetric canopy, utility pruning on west side, impermeable asphalt driveway within dripline |
| 2 | *Thuja plicata* | Western red cedar | 27.1 | No | Yes | Codominant structure beginning at 5 feet, asymmetric canopy, foliage appears chlorotic with heavy cone crop, long-term viability uncertain |
| 3 | *Pseudotsuga menziesii* | Douglas-fir | 48.5 | Yes | Yes* | Canopy appears in good condition, previously raised to 30+ feet, majority of dripline area covered by impermeable asphalt, large roots lifting/cracking asphalt surface<br>* Driveway on both sides of trunk, large/heavy vehicles during construction expected to negatively impact root zone immediately adjacent to tree |
| 4 | *Magnolia x soulangeana* | Saucer magnolia | 16.7 | No | Yes | Generally good condition, multi-stem structure, severe phototropic asymmetry |
| 5 | *Robinia pseudoacacia* | Black locust | 11 | No | Yes | Generally good condition, some visible deadwood, rooted on/near property line, dsh estimated due to blackberry brambles |
| 6 | *Chamaecyparis pisifera* | Sawara cypress | 14.5 | No | No | Tree girdled in multiple locations, bark stripped to 6 feet, not expected to survive |
| 7 | *Chamaecyparis pisifera* | Sawara cypress | 11.0 | No | No | Tree girdled, multiple 1/2-inch holes drilled, bark stripped to 6 feet, not expected to survive |
| 8 | *Prunus cerasifera* | Flowering plum | 20.7 | No* | No | Tree girdled in multiple locations, not expected to survive<br>* Measured dsh is less than 1/2-inch below MICC Exceptional threshold |
| 9 | *Robinia pseudoacacia* | Black locust | 12.7 | No | Yes | Generally good condition, rooted adjacent to old garage structure, anticipate asymmetric root zone |
| 10 | *Thuja plicata* | Western red cedar | 20.2 | No | No | Bark stripped to 8 feet, multiple 1/2-inch holes drilled, not expected to survive |
| 11 | *Thuja plicata* | Western red cedar | 12.7 | No | Yes | Generally good condition, growing in close proximity to tree 12 |
| 12 | *Thuja plicata* | Western red cedar | 13.6 | No | Yes | Generally good condition, growing in close proximity to tree 11 |
| 13 | *Acer negundo* | Box elder | 13.0 | No | Yes | Heavy phototropic lean toward lake and existing dock, no visible indication of instability |
| 14 | *Thuja plicata* | Western red cedar | 37.5 | Yes | Yes | Generally good condition, codominant structure beginning at 4 feet, significant ivy growth on trunk |
| 15 | *Thuja plicata* | Western red cedar | 36.1 | Yes | No | Tree dead, bark stripped to 3-4 feet, multiple 1/2-inch holes drilled |

| | | | | | | |
|---|---|---|---|---|---|---|
| 16 | *Pseudotsuga menziesii* | Douglas-fir | 40.8 | Yes | Yes | Good condition, may have previously lost top |
| A | *Thuja plicata* | Western red cedar | 24 | No | Yes | Overhangs from neighboring property (west), generally good condition, multi-stem structure, dsh estimated due to property boundary |
| B | *Robinia pseudoacacia* | Black locust | 11 | No | Yes | Overhangs from neighboring property (west), codominant structure beginning at 6 feet, generally good condition, dsh estimated due to blackberry brambles |
| C | *Acer negundo* | Box elder | 24 | No | Yes | Overhangs from neighboring property (south), generally good condition, dsh estimated due to property boundary |

## Summary

This inventory identified 19 total trees, with 16 within the site boundaries and 3 overhanging from neighboring properties. Within the site boundaries site, five (5) trees were identified as being dead, girdled, de-barked and/or drilled with the apparent intent of causing tree mortality. While some of these trees currently retain green foliage, visual inspection suggests none of these trees are expected to survive. It appears this intentional damage occurred within the past two (2) years.

The site also includes numerous large English laurel *(Prunus laurocerasus)*, Rhododendron and Camellia, some with stems exceeding 10 inches diameter. Due to these species typically being characterized as shrubs, they are not included in this inventory.

This inventory identified four (4) Exceptional trees and a total of five (5) large trees greater than 24 inches diameter. One of the exceptional trees (#15) is now dead, likely due to intentional damage.

Mercer Island City Code (MICC) requires retention of at least 30% of regulated trees during/after construction. This inventory identified 11 trees that are suitable for retention. Trees with severe visible damage – as described above – are not included in this figure. At the 30% retention level per MICC, at least four (4) of the trees in good condition are required to be retained.

## Assumptions & Limitations

1. Consultant has agreed to undertake Services on the subject Site. Consultant assumes that the Client owns or is the agent for the owner of the Site and that the legal description of the site provided by the Client is accurate. Consultant assumes that Client has granted license for Site access for the limited purpose of providing Services.
2. Consultant assumes that the Site and its use do not violate and is in compliance with all applicable codes, ordinances, statutes or regulations.
3. The Client is responsible for making all relevant records and related information available to the Consultant in a timely manner and for the accuracy and completeness of that information. Consultant may also obtain information from other sources that it considers reliable. Nonetheless, Client is responsible for the accuracy and completeness of that additional information and Consultant assumes no obligation for the accuracy and completeness of that additional information.
4. Consultant may provide report or recommendations based on published municipal regulations. The Consultant assumes that the municipal regulations published on the date of the report/recommendation are current and assumes no obligation related to unpublished city regulation information.
5. Any reports and the analysis and recommendations included represent the opinion of Consultant. Our fee is in no way contingent upon any specified result or occurrence of a subsequent event, nor upon any finding to be reported.
6. Consultant assessments are made in conformity with acceptable evaluation, diagnostic and reporting techniques and procedures as recommended by the International Society of Arboriculture.
7. All Services and reports consider only known targets and visible/accessible tree conditions without dissection, excavation, probing, climbing or coring. Measurements are subject to typical margins of error, considering the oval or asymmetrical cross-section of most trunks and canopies.
8. All observations and conclusions reflect the condition of the tree(s) and Site at the time of inspection, based on observable factors at the day and time of inspection. The timeframe for risk categorization should not be considered a guarantee period for the tree or level of risk. Only those tree(s) specified in the scope of work were assessed. Please keep in mind; any tree, whether it has visible weaknesses or not, will fail if the forces applied exceed the strength of the tree of its parts.
9. Tree(s) included in this project are evaluated as though under responsible ownership and competent management.
10. Consultant shall not be required to give testimony or to attend court by reason of this report unless subsequent contractual arrangements are made, including payment of an additional fee for such services.
11. Any documentation/reporting resulting from this project shall be used for intended purposes only and by the parties to whom they are addressed. Possession of this report does not include the right of publication. Loss or alteration of any part of this report invalidates the entire report.
12. Neither all or any part of the contents of resulting documentation/reporting, nor copy thereof, shall be conveyed by anyone, including the client, to the public through advertising, public relations, news, sales, or other media, without prior expressed written consent of Consultant.
13. Sketches, diagrams, graphs and images in this report are intended as visual aids. They are not necessarily to scale and should be not construed as engineering or architectural reports or surveys.
14. Consultant reserves the right to amend conclusions or recommendations if additional relevant information is made available.
15. Consultant makes no warranty or guarantee, express or implied, that problems or deficiencies of the tree(s) or Site in question may not arise in the future. Any report is based on the opinions of the authoring arborist and does not provide guarantees regarding the future performance, health, vitality, structural stability or safety of the tree(s) described or assessed. Neither the arborist nor Tree Solutions LLC has assumed any responsibility for liability associated with the trees on or adjacent to this project Site, their future demise and/or any damage which may result therefrom. Any changes to an established tree's environment can cause decline, death and/or structural failure.

END OF REPORT

----------------------------

Dheeraj Koneru
Mercer Island, WA

# APPENDIX C
## Calculations

*THIS PAGE IS INTENTIONALLY LEFT BLANK.*

**WWHM2012**
**PROJECT REPORT**

---

**Project Name:** Koneru Water Quality Rate
**Site Name:** Koneru Residence
**Site Address:** 6610 E Mercer Way
**City** : Mercer Island
**Report Date:** 8/13/2021
**Gage** : Seatac
**Data Start** : 1948/10/01
**Data End** : 2009/09/30
**Precip Scale:** 1.00
**Version Date:** 2019/09/13
**Version** : 4.2.17

---

**Low Flow Threshold for POC 1** : 50 Percent of the 2 Year

---

**High Flow Threshold for POC 1:** 50 year

---

**PREDEVELOPED LAND USE**

**Name** : Basin 1
**Bypass:** No

**GroundWater:** No

| Pervious Land Use | acre |
|---|---|
| C, Forest, Mod | .86 |
| C, Forest, Steep | .06 |

**Pervious Total** 0.92

| Impervious Land Use | acre |
|---|---|
| ROOF TOPS FLAT | 0.13 |
| DRIVEWAYS FLAT | 0.1 |

**Impervious Total** 0.23

**Basin Total** 1.15

---

**Element Flows To:**

| Surface | Interflow | Groundwater |
|---|---|---|

---

**MITIGATED LAND USE**

**Name** : Basin 1
**Bypass:** No

**GroundWater:** No

| **Pervious Land Use** | **acre** |
|---|---|
| **C, Lawn, Flat** | **.7** |

**Pervious Total** **0.7**

| **Impervious Land Use** | **acre** |
|---|---|
| **ROOF TOPS FLAT** | **0.45** |

**Impervious Total** **0.45**

**Basin Total** **1.15**

---

**Element Flows To:**

| **Surface** | **Interflow** | **Groundwater** |
|---|---|---|

---

---

**ANALYSIS RESULTS**

**Stream Protection Duration**

---

**Predeveloped Landuse Totals for POC #1**
**Total Pervious Area:0.92**
**Total Impervious Area:0.23**

---

**Mitigated Landuse Totals for POC #1**
**Total Pervious Area:0.7**
**Total Impervious Area:0.45**

---

**Flow Frequency Return Periods for Predeveloped. POC #1**

| **Return Period** | **Flow(cfs)** |
|---|---|
| **2 year** | 0.103363 |
| **5 year** | 0.135482 |
| **10 year** | 0.157935 |
| **25 year** | 0.187718 |
| **50 year** | 0.210965 |
| **100 year** | 0.235145 |

**Flow Frequency Return Periods for Mitigated. POC #1**

| **Return Period** | **Flow(cfs)** |
|---|---|
| **2 year** | 0.219748 |
| **5 year** | 0.300982 |
| **10 year** | 0.359716 |
| **25 year** | 0.439726 |

| | |
|---|---|
| **50 year** | 0.503649 |
| **100 year** | 0.571365 |

---

**Stream Protection Duration**
**Annual Peaks for Predeveloped and Mitigated. POC #1**

| Year | Predeveloped | Mitigated |
|---|---|---|
| 1949 | 0.146 | 0.324 |
| 1950 | 0.130 | 0.313 |
| 1951 | 0.106 | 0.200 |
| 1952 | 0.074 | 0.134 |
| 1953 | 0.069 | 0.142 |
| 1954 | 0.087 | 0.177 |
| 1955 | 0.094 | 0.191 |
| 1956 | 0.090 | 0.190 |
| 1957 | 0.116 | 0.243 |
| 1958 | 0.081 | 0.167 |
| 1959 | 0.074 | 0.146 |
| 1960 | 0.115 | 0.211 |
| 1961 | 0.095 | 0.200 |
| 1962 | 0.068 | 0.146 |
| 1963 | 0.091 | 0.194 |
| 1964 | 0.082 | 0.174 |
| 1965 | 0.108 | 0.258 |
| 1966 | 0.078 | 0.146 |
| 1967 | 0.137 | 0.317 |
| 1968 | 0.122 | 0.299 |
| 1969 | 0.091 | 0.233 |
| 1970 | 0.099 | 0.203 |
| 1971 | 0.108 | 0.243 |
| 1972 | 0.124 | 0.309 |
| 1973 | 0.071 | 0.128 |
| 1974 | 0.101 | 0.236 |
| 1975 | 0.122 | 0.249 |
| 1976 | 0.092 | 0.182 |
| 1977 | 0.075 | 0.171 |
| 1978 | 0.091 | 0.209 |
| 1979 | 0.125 | 0.257 |
| 1980 | 0.162 | 0.359 |
| 1981 | 0.099 | 0.220 |
| 1982 | 0.159 | 0.364 |
| 1983 | 0.105 | 0.231 |
| 1984 | 0.076 | 0.163 |
| 1985 | 0.092 | 0.222 |
| 1986 | 0.115 | 0.201 |
| 1987 | 0.123 | 0.262 |
| 1988 | 0.074 | 0.145 |
| 1989 | 0.093 | 0.182 |
| 1990 | 0.258 | 0.569 |
| 1991 | 0.179 | 0.409 |
| 1992 | 0.081 | 0.161 |
| 1993 | 0.061 | 0.127 |
| 1994 | 0.062 | 0.121 |
| 1995 | 0.089 | 0.190 |
| 1996 | 0.148 | 0.262 |
| 1997 | 0.118 | 0.232 |
| 1998 | 0.086 | 0.189 |

| | | |
|---|---|---|
| 1999 | 0.175 | 0.480 |
| 2000 | 0.103 | 0.221 |
| 2001 | 0.096 | 0.200 |
| 2002 | 0.121 | 0.323 |
| 2003 | 0.123 | 0.251 |
| 2004 | 0.168 | 0.439 |
| 2005 | 0.103 | 0.203 |
| 2006 | 0.095 | 0.189 |
| 2007 | 0.215 | 0.515 |
| 2008 | 0.189 | 0.401 |
| 2009 | 0.129 | 0.248 |

---

**Stream Protection Duration**
**Ranked Annual Peaks for Predeveloped and Mitigated. POC #1**

| **Rank** | **Predeveloped** | **Mitigated** |
|---|---|---|
| 1 | 0.2579 | 0.5689 |
| 2 | 0.2148 | 0.5150 |
| 3 | 0.1891 | 0.4800 |
| 4 | 0.1787 | 0.4385 |
| 5 | 0.1747 | 0.4086 |
| 6 | 0.1679 | 0.4006 |
| 7 | 0.1623 | 0.3644 |
| 8 | 0.1595 | 0.3593 |
| 9 | 0.1478 | 0.3238 |
| 10 | 0.1461 | 0.3227 |
| 11 | 0.1366 | 0.3166 |
| 12 | 0.1296 | 0.3135 |
| 13 | 0.1286 | 0.3088 |
| 14 | 0.1249 | 0.2990 |
| 15 | 0.1235 | 0.2624 |
| 16 | 0.1234 | 0.2617 |
| 17 | 0.1228 | 0.2580 |
| 18 | 0.1225 | 0.2572 |
| 19 | 0.1220 | 0.2510 |
| 20 | 0.1210 | 0.2493 |
| 21 | 0.1180 | 0.2477 |
| 22 | 0.1156 | 0.2435 |
| 23 | 0.1154 | 0.2432 |
| 24 | 0.1146 | 0.2363 |
| 25 | 0.1085 | 0.2335 |
| 26 | 0.1079 | 0.2322 |
| 27 | 0.1064 | 0.2310 |
| 28 | 0.1054 | 0.2225 |
| 29 | 0.1032 | 0.2207 |
| 30 | 0.1027 | 0.2196 |
| 31 | 0.1012 | 0.2105 |
| 32 | 0.0991 | 0.2094 |
| 33 | 0.0990 | 0.2034 |
| 34 | 0.0958 | 0.2032 |
| 35 | 0.0953 | 0.2005 |
| 36 | 0.0949 | 0.2001 |
| 37 | 0.0942 | 0.1998 |
| 38 | 0.0928 | 0.1997 |
| 39 | 0.0923 | 0.1935 |
| 40 | 0.0918 | 0.1906 |
| 41 | 0.0913 | 0.1904 |

| | | |
|---|---|---|
| 42 | 0.0913 | 0.1901 |
| 43 | 0.0910 | 0.1893 |
| 44 | 0.0902 | 0.1889 |
| 45 | 0.0887 | 0.1821 |
| 46 | 0.0874 | 0.1817 |
| 47 | 0.0861 | 0.1772 |
| 48 | 0.0821 | 0.1744 |
| 49 | 0.0812 | 0.1709 |
| 50 | 0.0807 | 0.1673 |
| 51 | 0.0777 | 0.1627 |
| 52 | 0.0765 | 0.1614 |
| 53 | 0.0748 | 0.1464 |
| 54 | 0.0745 | 0.1463 |
| 55 | 0.0742 | 0.1458 |
| 56 | 0.0737 | 0.1453 |
| 57 | 0.0711 | 0.1421 |
| 58 | 0.0685 | 0.1336 |
| 59 | 0.0679 | 0.1281 |
| 60 | 0.0619 | 0.1265 |
| 61 | 0.0609 | 0.1212 |

---

**Stream Protection Duration**
**POC #1**
**The Facility FAILED**

**Facility FAILED duration standard for 1+ flows.**

| Flow(cfs) | Predev | Mit | Percentage | Pass/Fail |
|---|---|---|---|---|
| 0.0517 | 2971 | 13667 | 460 | Fail |
| 0.0533 | 2699 | 12649 | 468 | Fail |
| 0.0549 | 2443 | 11777 | 482 | Fail |
| 0.0565 | 2218 | 10936 | 493 | Fail |
| 0.0581 | 2010 | 10140 | 504 | Fail |
| 0.0597 | 1856 | 9458 | 509 | Fail |
| 0.0613 | 1694 | 8840 | 521 | Fail |
| 0.0629 | 1545 | 8260 | 534 | Fail |
| 0.0646 | 1398 | 7762 | 555 | Fail |
| 0.0662 | 1284 | 7229 | 563 | Fail |
| 0.0678 | 1175 | 6748 | 574 | Fail |
| 0.0694 | 1070 | 6305 | 589 | Fail |
| 0.0710 | 989 | 5865 | 593 | Fail |
| 0.0726 | 904 | 5508 | 609 | Fail |
| 0.0742 | 845 | 5193 | 614 | Fail |
| 0.0758 | 784 | 4883 | 622 | Fail |
| 0.0774 | 721 | 4581 | 635 | Fail |
| 0.0790 | 662 | 4269 | 644 | Fail |
| 0.0806 | 618 | 4006 | 648 | Fail |
| 0.0823 | 557 | 3762 | 675 | Fail |
| 0.0839 | 503 | 3525 | 700 | Fail |
| 0.0855 | 455 | 3326 | 730 | Fail |
| 0.0871 | 408 | 3151 | 772 | Fail |
| 0.0887 | 376 | 2962 | 787 | Fail |
| 0.0903 | 338 | 2783 | 823 | Fail |
| 0.0919 | 314 | 2633 | 838 | Fail |
| 0.0935 | 287 | 2481 | 864 | Fail |
| 0.0951 | 266 | 2342 | 880 | Fail |

| | | | | |
|---|---|---|---|---|
| 0.0967 | 240 | 2242 | 934 | Fail |
| 0.0983 | 226 | 2104 | 930 | Fail |
| 0.0999 | 210 | 2013 | 958 | Fail |
| 0.1016 | 192 | 1905 | 992 | Fail |
| 0.1032 | 182 | 1807 | 992 | Fail |
| 0.1048 | 174 | 1723 | 990 | Fail |
| 0.1064 | 166 | 1647 | 992 | Fail |
| 0.1080 | 152 | 1558 | 1025 | Fail |
| 0.1096 | 143 | 1476 | 1032 | Fail |
| 0.1112 | 133 | 1415 | 1063 | Fail |
| 0.1128 | 124 | 1347 | 1086 | Fail |
| 0.1144 | 114 | 1281 | 1123 | Fail |
| 0.1160 | 105 | 1225 | 1166 | Fail |
| 0.1176 | 98 | 1160 | 1183 | Fail |
| 0.1193 | 93 | 1109 | 1192 | Fail |
| 0.1209 | 88 | 1052 | 1195 | Fail |
| 0.1225 | 83 | 1004 | 1209 | Fail |
| 0.1241 | 74 | 964 | 1302 | Fail |
| 0.1257 | 69 | 935 | 1355 | Fail |
| 0.1273 | 64 | 890 | 1390 | Fail |
| 0.1289 | 61 | 853 | 1398 | Fail |
| 0.1305 | 54 | 804 | 1488 | Fail |
| 0.1321 | 52 | 773 | 1486 | Fail |
| 0.1337 | 49 | 735 | 1500 | Fail |
| 0.1353 | 47 | 708 | 1506 | Fail |
| 0.1370 | 39 | 679 | 1741 | Fail |
| 0.1386 | 39 | 656 | 1682 | Fail |
| 0.1402 | 36 | 632 | 1755 | Fail |
| 0.1418 | 32 | 607 | 1896 | Fail |
| 0.1434 | 30 | 582 | 1940 | Fail |
| 0.1450 | 29 | 554 | 1910 | Fail |
| 0.1466 | 26 | 526 | 2023 | Fail |
| 0.1482 | 25 | 506 | 2024 | Fail |
| 0.1498 | 24 | 487 | 2029 | Fail |
| 0.1514 | 24 | 473 | 1970 | Fail |
| 0.1530 | 22 | 460 | 2090 | Fail |
| 0.1547 | 22 | 442 | 2009 | Fail |
| 0.1563 | 21 | 430 | 2047 | Fail |
| 0.1579 | 19 | 418 | 2200 | Fail |
| 0.1595 | 16 | 402 | 2512 | Fail |
| 0.1611 | 14 | 396 | 2828 | Fail |
| 0.1627 | 13 | 379 | 2915 | Fail |
| 0.1643 | 12 | 371 | 3091 | Fail |
| 0.1659 | 12 | 362 | 3016 | Fail |
| 0.1675 | 11 | 345 | 3136 | Fail |
| 0.1691 | 10 | 330 | 3300 | Fail |
| 0.1707 | 10 | 326 | 3259 | Fail |
| 0.1724 | 10 | 312 | 3120 | Fail |
| 0.1740 | 9 | 307 | 3411 | Fail |
| 0.1756 | 7 | 298 | 4257 | Fail |
| 0.1772 | 7 | 291 | 4157 | Fail |
| 0.1788 | 7 | 285 | 4071 | Fail |
| 0.1804 | 6 | 278 | 4633 | Fail |
| 0.1820 | 6 | 270 | 4500 | Fail |
| 0.1836 | 6 | 260 | 4333 | Fail |
| 0.1852 | 6 | 251 | 4183 | Fail |
| 0.1868 | 5 | 249 | 4980 | Fail |

| | | | | |
|---|---|---|---|---|
| 0.1884 | 5 | 239 | 4780 | Fail |
| 0.1900 | 4 | 230 | 5750 | Fail |
| 0.1917 | 4 | 218 | 5450 | Fail |
| 0.1933 | 4 | 204 | 5100 | Fail |
| 0.1949 | 4 | 199 | 4975 | Fail |
| 0.1965 | 3 | 196 | 6533 | Fail |
| 0.1981 | 3 | 191 | 6366 | Fail |
| 0.1997 | 3 | 186 | 6200 | Fail |
| 0.2013 | 3 | 177 | 5900 | Fail |
| 0.2029 | 3 | 166 | 5533 | Fail |
| 0.2045 | 3 | 161 | 5366 | Fail |
| 0.2061 | 3 | 154 | 5133 | Fail |
| 0.2077 | 3 | 153 | 5100 | Fail |
| 0.2094 | 3 | 150 | 5000 | Fail |
| 0.2110 | 2 | 146 | 7300 | Fail |

**The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.**
**The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.**

## LID Duration

**LID Duration**
**Annual Peaks for Predeveloped and Mitigated. POC #1**

| Year | Predeveloped | Mitigated |
|---|---|---|
| 1949 | 0.146 | 0.324 |
| 1950 | 0.130 | 0.313 |
| 1951 | 0.106 | 0.200 |
| 1952 | 0.074 | 0.134 |
| 1953 | 0.069 | 0.142 |
| 1954 | 0.087 | 0.177 |
| 1955 | 0.094 | 0.191 |
| 1956 | 0.090 | 0.190 |
| 1957 | 0.116 | 0.243 |
| 1958 | 0.081 | 0.167 |
| 1959 | 0.074 | 0.146 |
| 1960 | 0.115 | 0.211 |
| 1961 | 0.095 | 0.200 |
| 1962 | 0.068 | 0.146 |
| 1963 | 0.091 | 0.194 |
| 1964 | 0.082 | 0.174 |
| 1965 | 0.108 | 0.258 |
| 1966 | 0.078 | 0.146 |
| 1967 | 0.137 | 0.317 |
| 1968 | 0.122 | 0.299 |
| 1969 | 0.091 | 0.233 |
| 1970 | 0.099 | 0.203 |
| 1971 | 0.108 | 0.243 |
| 1972 | 0.124 | 0.309 |
| 1973 | 0.071 | 0.128 |
| 1974 | 0.101 | 0.236 |
| 1975 | 0.122 | 0.249 |

| | | |
|---|---|---|
| 1976 | 0.092 | 0.182 |
| 1977 | 0.075 | 0.171 |
| 1978 | 0.091 | 0.209 |
| 1979 | 0.125 | 0.257 |
| 1980 | 0.162 | 0.359 |
| 1981 | 0.099 | 0.220 |
| 1982 | 0.159 | 0.364 |
| 1983 | 0.105 | 0.231 |
| 1984 | 0.076 | 0.163 |
| 1985 | 0.092 | 0.222 |
| 1986 | 0.115 | 0.201 |
| 1987 | 0.123 | 0.262 |
| 1988 | 0.074 | 0.145 |
| 1989 | 0.093 | 0.182 |
| 1990 | 0.258 | 0.569 |
| 1991 | 0.179 | 0.409 |
| 1992 | 0.081 | 0.161 |
| 1993 | 0.061 | 0.127 |
| 1994 | 0.062 | 0.121 |
| 1995 | 0.089 | 0.190 |
| 1996 | 0.148 | 0.262 |
| 1997 | 0.118 | 0.232 |
| 1998 | 0.086 | 0.189 |
| 1999 | 0.175 | 0.480 |
| 2000 | 0.103 | 0.221 |
| 2001 | 0.096 | 0.200 |
| 2002 | 0.121 | 0.323 |
| 2003 | 0.123 | 0.251 |
| 2004 | 0.168 | 0.439 |
| 2005 | 0.103 | 0.203 |
| 2006 | 0.095 | 0.189 |
| 2007 | 0.215 | 0.515 |
| 2008 | 0.189 | 0.401 |
| 2009 | 0.129 | 0.248 |

---

**LID Duration**
**Ranked Annual Peaks for Predeveloped and Mitigated. POC #1**

| Rank | Predeveloped | Mitigated |
|---|---|---|
| 1 | 0.2579 | 0.5689 |
| 2 | 0.2148 | 0.5150 |
| 3 | 0.1891 | 0.4800 |
| 4 | 0.1787 | 0.4385 |
| 5 | 0.1747 | 0.4086 |
| 6 | 0.1679 | 0.4006 |
| 7 | 0.1623 | 0.3644 |
| 8 | 0.1595 | 0.3593 |
| 9 | 0.1478 | 0.3238 |
| 10 | 0.1461 | 0.3227 |
| 11 | 0.1366 | 0.3166 |
| 12 | 0.1296 | 0.3135 |
| 13 | 0.1286 | 0.3088 |
| 14 | 0.1249 | 0.2990 |
| 15 | 0.1235 | 0.2624 |
| 16 | 0.1234 | 0.2617 |
| 17 | 0.1228 | 0.2580 |
| 18 | 0.1225 | 0.2572 |

| | | |
|---|---|---|
| 19 | 0.1220 | 0.2510 |
| 20 | 0.1210 | 0.2493 |
| 21 | 0.1180 | 0.2477 |
| 22 | 0.1156 | 0.2435 |
| 23 | 0.1154 | 0.2432 |
| 24 | 0.1146 | 0.2363 |
| 25 | 0.1085 | 0.2335 |
| 26 | 0.1079 | 0.2322 |
| 27 | 0.1064 | 0.2310 |
| 28 | 0.1054 | 0.2225 |
| 29 | 0.1032 | 0.2207 |
| 30 | 0.1027 | 0.2196 |
| 31 | 0.1012 | 0.2105 |
| 32 | 0.0991 | 0.2094 |
| 33 | 0.0990 | 0.2034 |
| 34 | 0.0958 | 0.2032 |
| 35 | 0.0953 | 0.2005 |
| 36 | 0.0949 | 0.2001 |
| 37 | 0.0942 | 0.1998 |
| 38 | 0.0928 | 0.1997 |
| 39 | 0.0923 | 0.1935 |
| 40 | 0.0918 | 0.1906 |
| 41 | 0.0913 | 0.1904 |
| 42 | 0.0913 | 0.1901 |
| 43 | 0.0910 | 0.1893 |
| 44 | 0.0902 | 0.1889 |
| 45 | 0.0887 | 0.1821 |
| 46 | 0.0874 | 0.1817 |
| 47 | 0.0861 | 0.1772 |
| 48 | 0.0821 | 0.1744 |
| 49 | 0.0812 | 0.1709 |
| 50 | 0.0807 | 0.1673 |
| 51 | 0.0777 | 0.1627 |
| 52 | 0.0765 | 0.1614 |
| 53 | 0.0748 | 0.1464 |
| 54 | 0.0745 | 0.1463 |
| 55 | 0.0742 | 0.1458 |
| 56 | 0.0737 | 0.1453 |
| 57 | 0.0711 | 0.1421 |
| 58 | 0.0685 | 0.1336 |
| 59 | 0.0679 | 0.1281 |
| 60 | 0.0619 | 0.1265 |
| 61 | 0.0609 | 0.1212 |

---

**LID Duration**
**POC #1**
**The Facility FAILED**

**Facility FAILED duration standard for 1+ flows.**

| Flow(cfs) | Predev | Mit | Percentage | Pass/Fail |
|---|---|---|---|---|
| 0.0083 | 123028 | 192628 | 156 | Fail |
| 0.0087 | 116163 | 184093 | 158 | Fail |
| 0.0091 | 109874 | 176158 | 160 | Fail |
| 0.0096 | 103971 | 168865 | 162 | Fail |
| 0.0100 | 98645 | 162127 | 164 | Fail |

| | | | | |
|---|---|---|---|---|
| 0.0105 | 93619 | 155796 | 166 | Fail |
| 0.0109 | 88849 | 149893 | 168 | Fail |
| 0.0113 | 84507 | 144353 | 170 | Fail |
| 0.0118 | 80187 | 139006 | 173 | Fail |
| 0.0122 | 76294 | 133937 | 175 | Fail |
| 0.0127 | 72572 | 129124 | 177 | Fail |
| 0.0131 | 69022 | 124675 | 180 | Fail |
| 0.0135 | 65749 | 120547 | 183 | Fail |
| 0.0140 | 62712 | 116655 | 186 | Fail |
| 0.0144 | 59824 | 112805 | 188 | Fail |
| 0.0148 | 57065 | 109190 | 191 | Fail |
| 0.0153 | 54434 | 105746 | 194 | Fail |
| 0.0157 | 51932 | 102410 | 197 | Fail |
| 0.0162 | 49579 | 99158 | 200 | Fail |
| 0.0166 | 47355 | 96057 | 202 | Fail |
| 0.0170 | 45387 | 93212 | 205 | Fail |
| 0.0175 | 43483 | 90475 | 208 | Fail |
| 0.0179 | 41623 | 87737 | 210 | Fail |
| 0.0184 | 39783 | 85127 | 213 | Fail |
| 0.0188 | 38093 | 82646 | 216 | Fail |
| 0.0192 | 36532 | 80251 | 219 | Fail |
| 0.0197 | 35035 | 77962 | 222 | Fail |
| 0.0201 | 33623 | 75823 | 225 | Fail |
| 0.0205 | 32190 | 73727 | 229 | Fail |
| 0.0210 | 30885 | 71695 | 232 | Fail |
| 0.0214 | 29645 | 69749 | 235 | Fail |
| 0.0219 | 28468 | 67909 | 238 | Fail |
| 0.0223 | 27335 | 65984 | 241 | Fail |
| 0.0227 | 26265 | 64188 | 244 | Fail |
| 0.0232 | 25260 | 62455 | 247 | Fail |
| 0.0236 | 24234 | 60766 | 250 | Fail |
| 0.0241 | 23292 | 59140 | 253 | Fail |
| 0.0245 | 22415 | 57579 | 256 | Fail |
| 0.0249 | 21496 | 55996 | 260 | Fail |
| 0.0254 | 20687 | 54456 | 263 | Fail |
| 0.0258 | 19902 | 53044 | 266 | Fail |
| 0.0262 | 19122 | 51675 | 270 | Fail |
| 0.0267 | 18433 | 50392 | 273 | Fail |
| 0.0271 | 17708 | 49130 | 277 | Fail |
| 0.0276 | 17064 | 47890 | 280 | Fail |
| 0.0280 | 16450 | 46670 | 283 | Fail |
| 0.0284 | 15860 | 45515 | 286 | Fail |
| 0.0289 | 15297 | 44403 | 290 | Fail |
| 0.0293 | 14720 | 43227 | 293 | Fail |
| 0.0298 | 14183 | 42200 | 297 | Fail |
| 0.0302 | 13732 | 41152 | 299 | Fail |
| 0.0306 | 13244 | 40147 | 303 | Fail |
| 0.0311 | 12818 | 39184 | 305 | Fail |
| 0.0315 | 12371 | 38265 | 309 | Fail |
| 0.0319 | 11967 | 37366 | 312 | Fail |
| 0.0324 | 11565 | 36489 | 315 | Fail |
| 0.0328 | 11118 | 35591 | 320 | Fail |
| 0.0333 | 10737 | 34778 | 323 | Fail |
| 0.0337 | 10352 | 33965 | 328 | Fail |
| 0.0341 | 9984 | 33153 | 332 | Fail |
| 0.0346 | 9663 | 32361 | 334 | Fail |
| 0.0350 | 9366 | 31591 | 337 | Fail |

| | | | | |
|---|---|---|---|---|
| 0.0355 | 9073 | 30864 | 340 | Fail |
| 0.0359 | 8789 | 30137 | 342 | Fail |
| 0.0363 | 8519 | 29388 | 344 | Fail |
| 0.0368 | 8239 | 28704 | 348 | Fail |
| 0.0372 | 7984 | 28019 | 350 | Fail |
| 0.0376 | 7738 | 27420 | 354 | Fail |
| 0.0381 | 7497 | 26800 | 357 | Fail |
| 0.0385 | 7255 | 26223 | 361 | Fail |
| 0.0390 | 7039 | 25624 | 364 | Fail |
| 0.0394 | 6808 | 25025 | 367 | Fail |
| 0.0398 | 6583 | 24405 | 370 | Fail |
| 0.0403 | 6380 | 23870 | 374 | Fail |
| 0.0407 | 6177 | 23357 | 378 | Fail |
| 0.0412 | 6006 | 22843 | 380 | Fail |
| 0.0416 | 5786 | 22330 | 385 | Fail |
| 0.0420 | 5630 | 21838 | 387 | Fail |
| 0.0425 | 5454 | 21346 | 391 | Fail |
| 0.0429 | 5298 | 20890 | 394 | Fail |
| 0.0433 | 5157 | 20435 | 396 | Fail |
| 0.0438 | 5003 | 19977 | 399 | Fail |
| 0.0442 | 4855 | 19504 | 401 | Fail |
| 0.0447 | 4712 | 19104 | 405 | Fail |
| 0.0451 | 4556 | 18681 | 410 | Fail |
| 0.0455 | 4423 | 18311 | 413 | Fail |
| 0.0460 | 4312 | 17907 | 415 | Fail |
| 0.0464 | 4211 | 17543 | 416 | Fail |
| 0.0469 | 4081 | 17188 | 421 | Fail |
| 0.0473 | 3946 | 16837 | 426 | Fail |
| 0.0477 | 3826 | 16484 | 430 | Fail |
| 0.0482 | 3709 | 16166 | 435 | Fail |
| 0.0486 | 3623 | 15783 | 435 | Fail |
| 0.0491 | 3529 | 15441 | 437 | Fail |
| 0.0495 | 3431 | 15163 | 441 | Fail |
| 0.0499 | 3330 | 14872 | 446 | Fail |
| 0.0504 | 3245 | 14547 | 448 | Fail |
| 0.0508 | 3151 | 14247 | 452 | Fail |
| 0.0512 | 3054 | 13956 | 456 | Fail |
| 0.0517 | 2971 | 13667 | 460 | Fail |

---

**The development has an increase in flow durations from 8% of the 2 year flow to the 50 year flow**
**The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.**

---

**Water Quality BMP Flow and Volume for POC #1**
**On-line facility volume:** 0.0789 **acre-feet**
**On-line facility target flow:** 0.0742 **cfs.**
**Adjusted for 15 min:** 0.0742 **cfs.**
**Off-line facility target flow:** 0.0409 **cfs.**
**Adjusted for 15 min:** 0.0409 **cfs.**

---

**LID Report**

| LID Technique | Used for Treatment? | Total Volume Needs Treatment | Volume Through Facility | Infiltration Volume | Cumulative Volume Infiltration Credit | Percent Volume Infiltrated | Water Quality | Percent Water Quality Treated | Comment |
|---|---|---|---|---|---|---|---|---|---|

Treatment? Needs Through Volume Volume
Volume Water Quality
Treatment Facility (ac-ft.) Infiltration
Infiltrated Treated
(ac-ft) (ac-ft) Credit

Total Volume Infiltrated 0.00 0.00 0.00 0.00
0.00 0% No Treat. Credit
Compliance with LID Standard 8
Duration Analysis Result = Failed

---

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run. POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run. POC #4 was not reported because POC must exist in both scenarios and both scenarios must have been run. POC #5 was not reported because POC must exist in both scenarios and both scenarios must have been run. POC #6 was not reported because POC must exist in both scenarios and both scenarios must have been run.**Perlnd and Implnd Changes**
No changes have been made.

---

Dheeraj Koneru
Mercer Island, WA

# APPENDIX D
## Operations and Maintenance Manual

## Table V-4.5.2(5) Maintenance Standards - Catch Basins

| Maintenance Component | Defect | Conditions When Maintenance is Needed | Results Expected When Maintenance is performed |
|---|---|---|---|
| General | Trash & Debris | Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.<br>Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.<br>Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.<br>Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane). | No Trash or debris located immediately in front of catch basin or on grate opening.<br>No trash or debris in the catch basin.<br>Inlet and outlet pipes free of trash or debris.<br>No dead animals or vegetation present within the catch basin. |
| | Sediment | Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe. | No sediment in the catch basin |
| | Structure Damage to Frame and/or Top Slab | Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin). | Top slab is free of holes and cracks.<br>Frame is sit- |

## Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

| Maintenance Component | Defect | Conditions When Maintenance is Needed | Results Expected When Maintenance is performed |
|---|---|---|---|
| | | Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached | ting flush on the riser rings or top slab and firmly attached. |
| | Fractures or Cracks in Basin Walls/ Bottom | Maintenance person judges that structure is unsound.<br>Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks. | Basin replaced or repaired to design standards.<br>Pipe is regrouted and secure at basin wall. |
| | Settlement/ Misalignment | If failure of basin has created a safety, function, or design problem. | Basin replaced or repaired to design standards. |
| | Vegetation | Vegetation growing across and blocking more than 10% of the basin opening.<br>Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart. | No vegetation blocking opening to basin.<br>No vegetation or root growth present. |
| | Contamination and Pollution | See "Detention Ponds" (No. 1). | No pollution present. |
| Catch Basin Cover | Cover Not in Place | Cover is missing or only partially in place. Any open catch basin requires maintenance. | Catch basin cover is closed |
| | Locking Mechanism Not | Mechanism cannot be opened by one maintenance person with proper tools. Bolts into | Mechanism opens with |

## Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

| Maintenance Component | Defect | Conditions When Maintenance is Needed | Results Expected When Maintenance is performed |
|---|---|---|---|
| | Working | frame have less than 1/2 inch of thread. | proper tools. |
| | Cover Difficult to Remove | One maintenance person cannot remove lid after applying normal lifting pressure.<br>(Intent is keep cover from sealing off access to maintenance.) | Cover can be removed by one maintenance person. |
| Ladder | Ladder Rungs Unsafe | Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges. | Ladder meets design standards and allows maintenance person safe access. |
| Metal Grates (If Applicable) | Grate opening Unsafe | Grate with opening wider than 7/8 inch. | Grate opening meets design standards. |
| | Trash and Debris | Trash and debris that is blocking more than 20% of grate surface inletting capacity. | Grate free of trash and debris. |
| | Damaged or Missing. | Grate missing or broken member(s) of the grate. | Grate is in place and meets design standards. |

## Table V-4.5.2(6) Maintenance Standards - Debris Barriers (e.g., Trash Racks)

| Maintenance Components | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| General | Trash and Debris | Trash or debris that is plugging more than 20% of the openings in the barrier. | Barrier cleared to design flow capacity. |
| Metal | Damaged/ Missing | Bars are bent out of shape more than 3 inches. | Bars in place with no bends more than 3/4 |

## Table V-4.5.2(6) Maintenance Standards - Debris Barriers (e.g., Trash Racks) (continued)

| Maintenance Components | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| | | | inch. |
| | Bars. | Bars are missing or entire barrier missing.<br>Bars are loose and rust is causing 50% deterioration to any part of barrier. | Bars in place according to design.<br>Barrier replaced or repaired to design standards. |
| | Inlet/Outlet Pipe | Debris barrier missing or not attached to pipe | Barrier firmly attached to pipe |

## Table V-4.5.2(7) Maintenance Standards - Energy Dissipaters

| Maintenance Components | Defect | Conditions When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| External: | | | |
| Rock Pad | Missing or Moved Rock | Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil. | Rock pad replaced to design standards. |
| | Erosion | Soil erosion in or adjacent to rock pad. | Rock pad replaced to design standards. |
| Dispersion Trench | Pipe Plugged with Sediment | Accumulated sediment that exceeds 20% of the design depth. | Pipe cleaned/flushed so that it matches design. |
| | Not Discharging Water Properly | Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage. | Trench redesigned or rebuilt to standards. |
| | Perforations Plugged. | Over 1/2 of perforations in pipe are plugged with debris and sediment. | Perforated pipe cleaned or replaced. |

### Table V-4.5.2(12) Maintenance Standards - Wetvaults (continued)

| Maintenance Component | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| | Frame and/or Top Slab | inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks. | exist wider than 1/4-inch at the joint of the inlet/outlet pipe. |
| | Baffles | Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff. | Baffles repaired or replaced to specifications. |
| | Access Ladder Damage | Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing. | Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards. |

### Table V-4.5.2(13) Maintenance Standards - Sand Filters (Above Ground/Open)

| Maintenance Component | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| Above Ground (open sand filter) | Sediment Accumulation on top layer | Sediment depth exceeds 1/2-inch. | No sediment deposit on grass layer of sand filter that would impede permeability of the filter section. |
| | Trash and Debris Accumulations | Trash and debris accumulated on sand filter bed. | Trash and debris removed from sand filter bed. |
| | Sediment/ Debris in Clean-Outs | When the clean-outs become full or partially plugged with sediment and/or debris. | Sediment removed from clean-outs. |
| | Sand Filter Media | Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow | Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging |

## Table V-4.5.2(13) Maintenance Standards - Sand Filters (Above Ground/Open) (continued)

| Maintenance Component | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| | | through the overflow pipes occurs frequently. | (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material). |
| | Prolonged Flows | Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities. | Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface. |
| | Short Circuiting | When flows become concentrated over one section of the sand filter rather than dispersed. | Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area. |
| | Erosion Damage to Slopes | Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident. | Slopes stabilized using proper erosion control measures. |
| | Rock Pad Missing or Out of Place | Soil beneath the rock is visible. | Rock pad replaced or rebuilt to design specifications. |
| | Flow Spreader | Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter. | Spreader leveled and cleaned so that flows are spread evenly over sand filter. |
| | Damaged Pipes | Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping. | Pipe repaired or replaced. |

## Table V-4.5.2(14) Maintenance Standards - Sand Filters (Below Ground/Enclosed)

| Maintenance Component | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| Below Ground Vault. | Sediment Accumulation on Sand Media Section | Sediment depth exceeds 1/2-inch. | No sediment deposits on sand filter section that which would impede permeability of the filter section. |
| | Sediment Accumulation in Pre-Settling Portion of Vault | Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches. | No sediment deposits in first chamber of vault. |
| | Trash/Debris Accumulation | Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables. | Trash and debris removed from vault and inlet/outlet piping. |
| | Sediment in Drain Pipes/Cleanouts | When drain pipes, cleanouts become full with sediment and/or debris. | Sediment and debris removed. |
| | Short Circuiting | When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area. | Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion. |
| | Damaged Pipes | Inlet or outlet piping damaged or broken and in need of repair. | Pipe repaired and/or replaced. |
| | Access Cover Damaged/Not Working | Cover cannot be opened, corrosion/deformation of cover.<br>Maintenance person cannot remove cover using normal lifting pressure. | Cover repaired to proper working specifications or replaced. |
| | Ventilation | Ventilation area blocked or plugged | Blocking material removed or cleared from ventilation |

**Table V-4.5.2(14) Maintenance Standards - Sand Filters (Below Ground/Enclosed) (continued)**

| Maintenance Component | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| | | | area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications). |
| | Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab. | Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.<br>Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks. | Vault replaced or repairs made so that vault meets design specifications and is structurally sound.<br>Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe. |
| | Baffles/Internal walls | Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person. | Baffles repaired or replaced to specifications. |
| | Access Ladder Damaged | Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned. | Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. |

**Table V-4.5.2(15) Maintenance Standards - Manufactured Media Filters**

| Maintenance Component | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| Below Ground Vault | Sediment Accu- | Sediment depth exceeds 0.25-inches. | No sediment depos- |

## Table V-4.5.2(15) Maintenance Standards - Manufactured Media Filters (continued)

| Maintenance Component | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| | mulation on Media. | | its which would impede permeability of the compost media. |
| | Sediment Accumulation in Vault | Sediment depth exceeds 6-inches in first chamber. | No sediment deposits in vault bottom of first chamber. |
| | Trash/Debris Accumulation | Trash and debris accumulated on compost filter bed. | Trash and debris removed from the compost filter bed. |
| | Sediment in Drain Pipes/Clean-Outs | When drain pipes, clean-outs, become full with sediment and/or debris. | Sediment and debris removed. |
| | Damaged Pipes | Any part of the pipes that are crushed or damaged due to corrosion and/or settlement. | Pipe repaired and/or replaced. |
| | Access Cover Damaged/Not Working | Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover. | Cover repaired to proper working specifications or replaced. |
| | Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab | Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. | Vault replaced or repairs made so that vault meets design specifications and is structurally sound. |
| | | Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks. | Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe. |
| | Baffles | Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person. | Baffles repaired or replaced to specifications. |

### Table V-4.5.2(15) Maintenance Standards - Manufactured Media Filters (continued)

| Maintenance Component | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| | Access Ladder Damaged | Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and mis-aligned. | Ladder replaced or repaired and meets specifications, and is safe to use as determ-ined by inspection personnel. |
| Below Ground Cart-ridge Type | Media | Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently. | Media cartridges replaced. |
| | Short Circuiting | Flows do not properly enter filter cartridges. | Filter cartridges replaced. |

### Table V-4.5.2(16) Maintenance Standards - Baffle Oil/Water Separators (API Type)

| Maintenance Component | Defect | Condition When Main-tenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| General | Monitoring | Inspection of discharge water for obvious signs of poor water quality. | Effluent discharge from vault should be clear with out thick visible sheen. |
| | Sediment Accu-mulation | Sediment depth in bottom of vault exceeds 6-inches in depth. | No sediment deposits on vault bottom that would impede flow through the vault and reduce separation effi-ciency. |
| | Trash and Debris Accumulation | Trash and debris accu-mulation in vault, or pipe inlet/outlet, floatables and non-floatables. | Trash and debris removed from vault, and inlet/outlet piping. |
| | Oil Accumulation | Oil accumulations that exceed 1-inch, at the surface of the water. | Extract oil from vault by vactoring. Disposal in accordance with state and local rules and reg-ulations. |

### Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators (continued)

| Maintenance Component | Defect | Condition When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| | | Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks. | inlet/outlet pipe. |
| | Access Ladder Damaged | Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned. | Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel. |

### Table V-4.5.2(18) Maintenance Standards - Catch Basin Inserts

| Maintenance Component | Defect | Conditions When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| General | Sediment Accumulation | When sediment forms a cap over the insert media of the insert and/or unit. | No sediment cap on the insert media and its unit. |
| | Trash and Debris Accumulation | Trash and debris accumulates on insert unit creating a blockage/restriction. | Trash and debris removed from insert unit. Runoff freely flows into catch basin. |
| | Media Insert Not Removing Oil | Effluent water from media insert has a visible sheen. | Effluent water from media insert is free of oils and has no visible sheen. |
| | Media Insert Water Saturated | Catch basin insert is saturated with water and no longer has the capacity to absorb. | Remove and replace media insert |
| | Media Insert-Oil Saturated | Media oil saturated due to petroleum spill that drains into catch basin. | Remove and replace media insert. |
| | Media Insert Use Beyond Product Life | Media has been used beyond the typical average life of media insert product. | Remove and replace media at regular intervals, depending on insert product. |

**Table V-4.5.2(19) Maintenance Standards - Media Filter Drain (MFD)**

| Maintenance Component | Defect | Conditions When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| General | Sediment accumulation on grass filter strip | Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheet flow. | Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased. |
| | No-vegetation zone/-flow spreader | Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width. | Level the spreader and clean to spread flows evenly over entire embankment width. |
| | Poor vegetation coverage | Grass is sparse or bare, or eroded patches are observed in more than 10% of the grass strip surface area. | Determine why grass growth is poor and correct the offending condition. Reseed into loosened, fertile soil or compost; or, replant with plugs of grass from the upper slope. |
| | Vegetation | Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over. | Mow vegetation or remove nuisance vegetation to not impede flow. Mow grass to a height of 6 inches. |
| | Media filter drain mix replacement | Water is seen on the surface of the media filter drain mix long after the storms have ceased. Typically, the 6-month, 24-hour precipitation event should drain within 48 hours. More common storms should drain within 24 hours. Maintenance also needed on a 10-year cycle and during a preservation project. | Excavate and replace all of the media filter drain mix contained within the media filter drain. |
| | Excessive shading | Grass growth is poor because sunlight does not reach | If possible, trim back overhanging limbs and remove |

## Table V-4.5.2(19) Maintenance Standards - Media Filter Drain (MFD) (continued)

| Maintenance Component | Defect | Conditions When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| | | embankment. | brushy vegetation on adjacent slopes. |
| | Trash and debris | Trash and debris have accumulated on embankment. | Remove trash and debris from embankment. |
| | Flooding of Media filter drain | When media filter drain is inundated by flood water | Evaluate media filter drain material for acceptable infiltration rate and replace if media filter drain does not meet long-term infiltration rate standards. |

## Table V-4.5.2(20) Maintenance Standards - Compost Amended Vegetated Filter Strip (CAVFS)

| Maintenance Component | Defect | Conditions When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| General | Sediment accumulation on grass | Sediment depth exceeds 2 inches. | Remove sediment deposits. Relevel so slope is even and flows pass evenly through strip. |
| | Vegetation | Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over. | Mow grass and control nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches. |
| | Trash and debris | Trash and debris have accumulated on the vegetated filter strip. | Remove trash and debris from filter. |

## Table V-4.5.2(20) Maintenance Standards - Compost Amended Vegetated Filter Strip (CAVFS) (continued)

| Maintenance Component | Defect | Conditions When Maintenance is Needed | Results Expected When Maintenance is Performed |
|---|---|---|---|
| | Erosion/scouring | Areas have eroded or scoured due to flow channelization or high flows. | For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with a 50/50 mixture of crushed gravel and compost. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the vegetated filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident. |
| | Flow spreader | Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width. | Level the spreader and clean so that flows are spread evenly over entire filter width |

## Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities

| Maintenance Component | Recommended Frequency a | | Condition when Maintenance is Needed (Standards) | Action Needed (Procedures) |
|---|---|---|---|---|
| | Inspection | Routine Maintenance | | |
| ***Facility Footprint*** | | | | |
| Earthen side slopes and berms | B, S | | Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes | • Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting)<br>• For deep channels or cuts (over 3 inches in ponding |